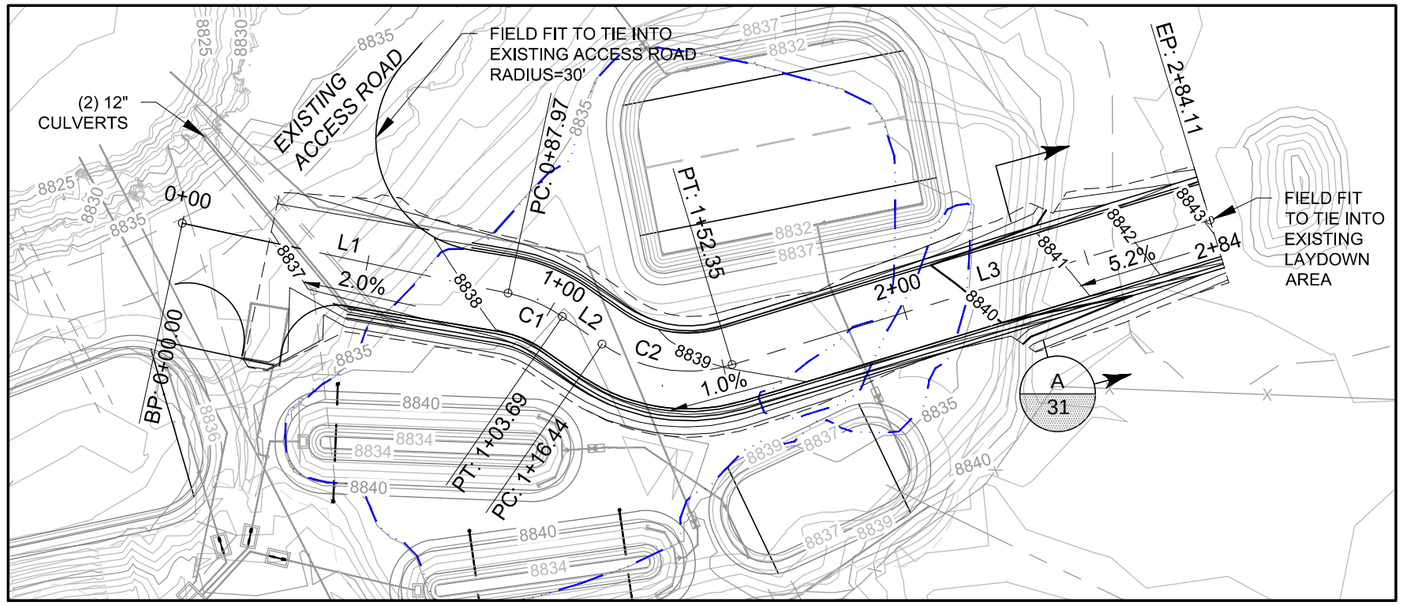

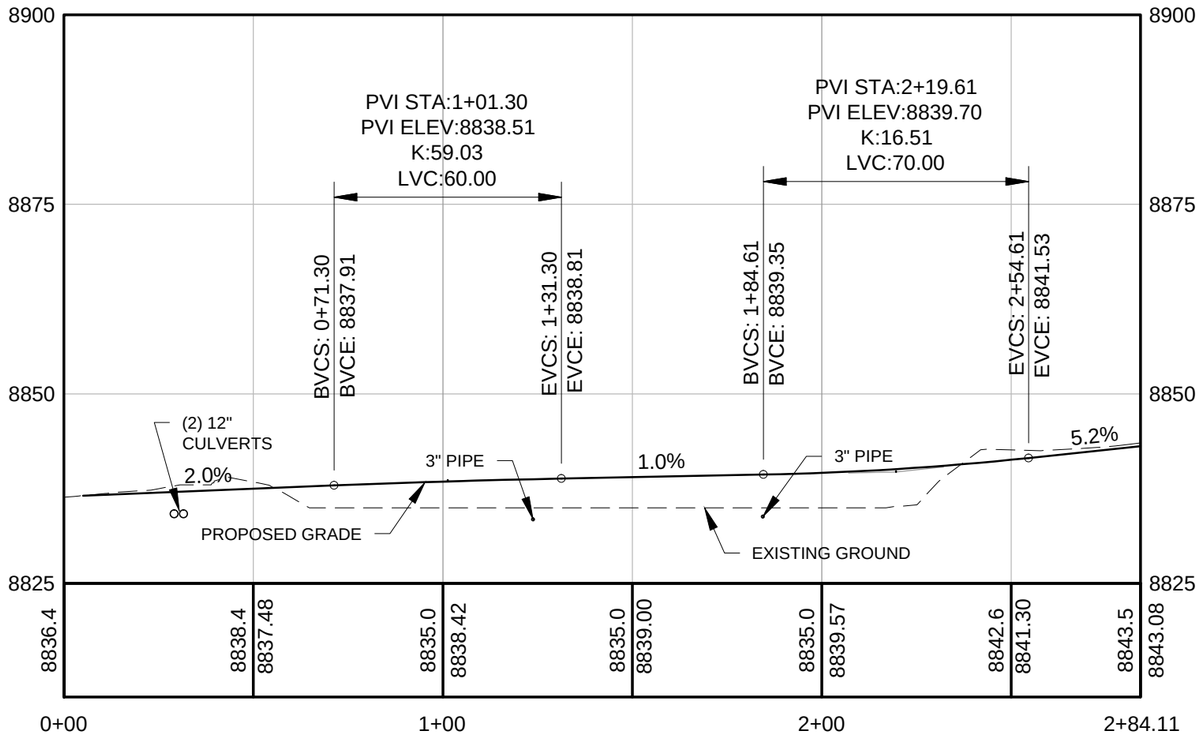

1290033

TREATMENT SYSTEM ACCESS ROAD						
SEGMENT	STARTING STATION	NORTHING	EASTING	DELTA (D-M-S)	RADIUS (FT)	LENGTH (FT)
L1	0+00.00	1,388,993.90	2,267,854.13			
C1	0+87.97	1,389,079.90	2,267,872.61	22-31-09	40.00	15.72
L2	1+03.69	1,389,094.24	2,267,878.81			
C2	1+16.44	1,389,104.73	2,267,886.06	51-27-04	40.00	35.92
L3	1+52.35	1,389,139.03	2,267,891.45			

NORTH
20 0 20 40 FT

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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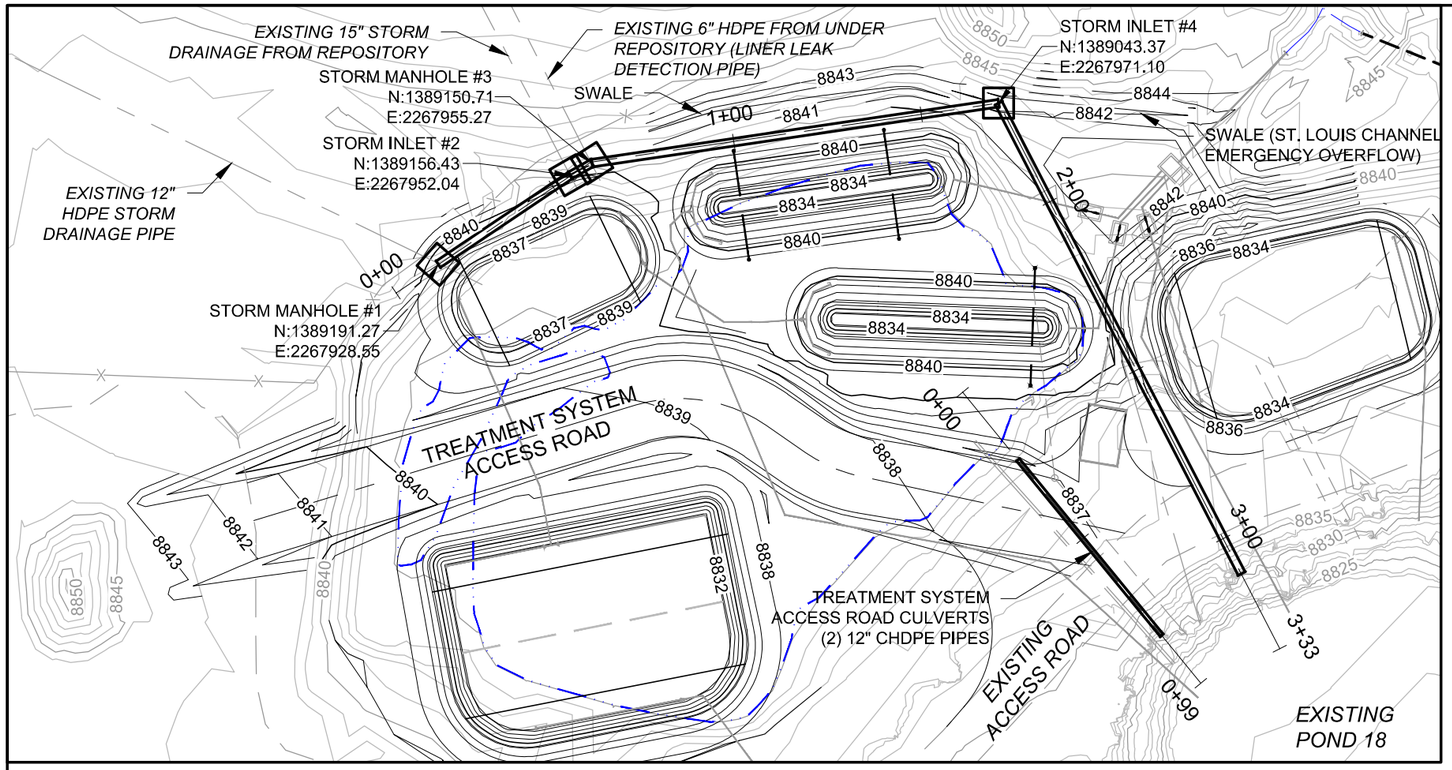
(916) 636-3200

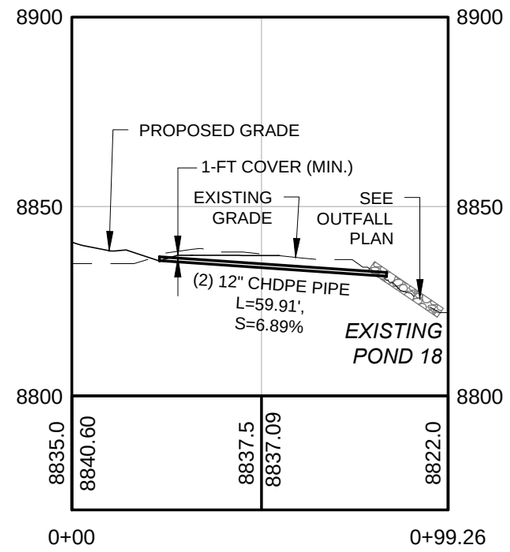
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

TREATMENT SYSTEM ACCESS ROAD PLAN AND PROFILE

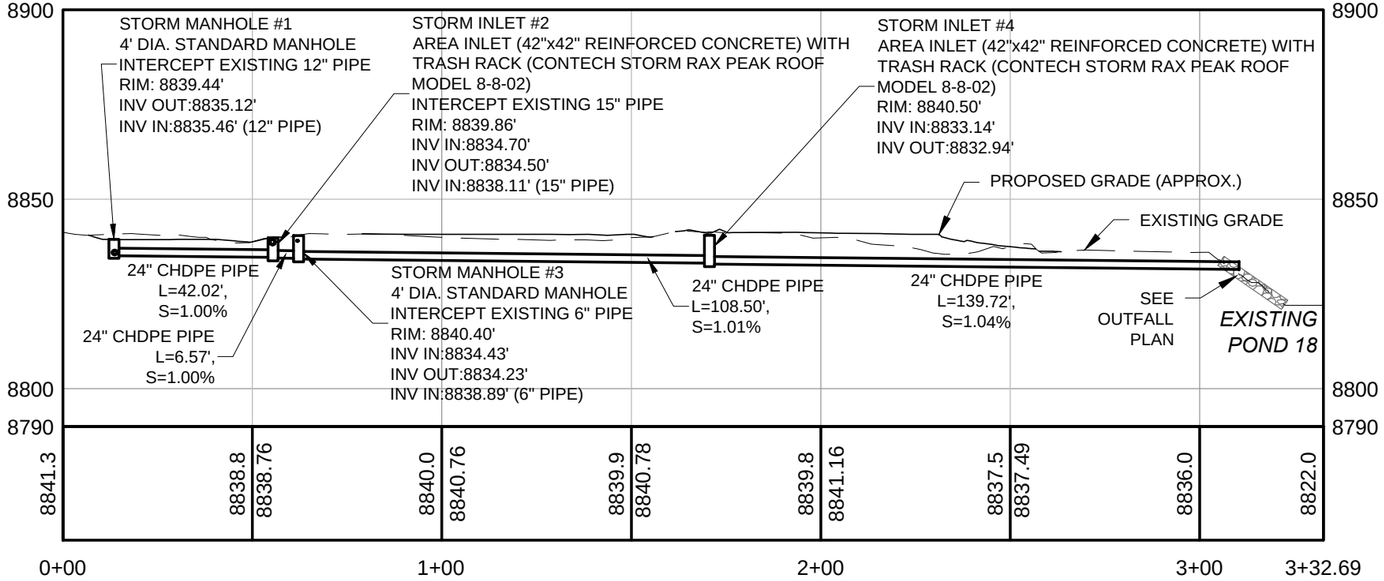
DATE: 05/31/13
SCALE: 1" = 40'
SHEET: 18 OF 42
PROJ No: SA11161315
18

Plot Date: 09/11/13 - 5:40pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: Access plan.dwg





TREATMENT SYSTEM ACCESS ROAD CULVERT PROFILE



24" STORM DRAIN

NOTES:

1. SEE DETAIL 2, SHEET 33 FOR TRENCH DETAIL.
2. CORE DRILL PRECAST MANHOLES AND INLETS PIPING WITH LINK-SEAL MODULAR SEALS (TYP.).
3. ALL MANHOLES AND INLETS CAN BE FLAT TOPS WITHOUT CONCENTRIC CONES.

3

NORTH

20 0 20 40 FT

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
3	ADDENDUM 1	08/16/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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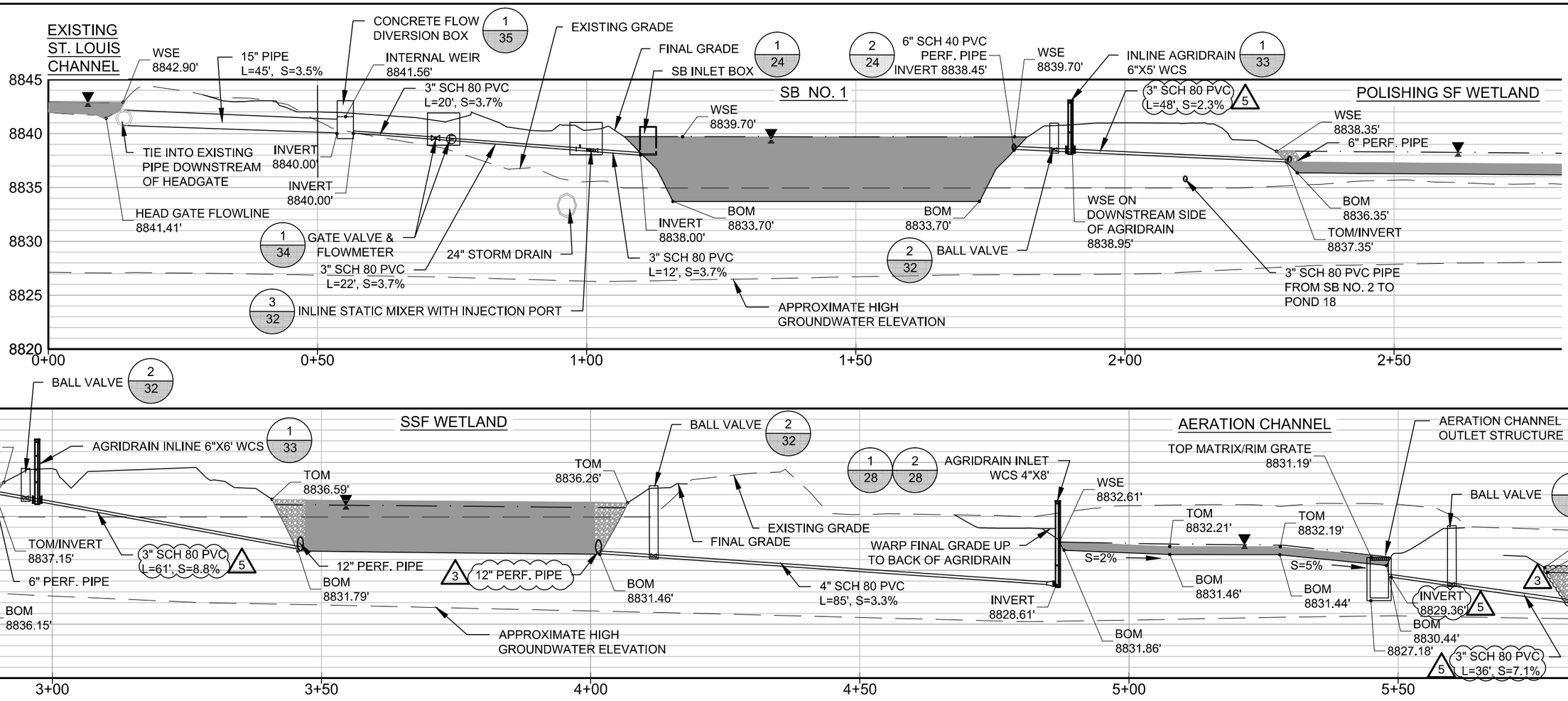
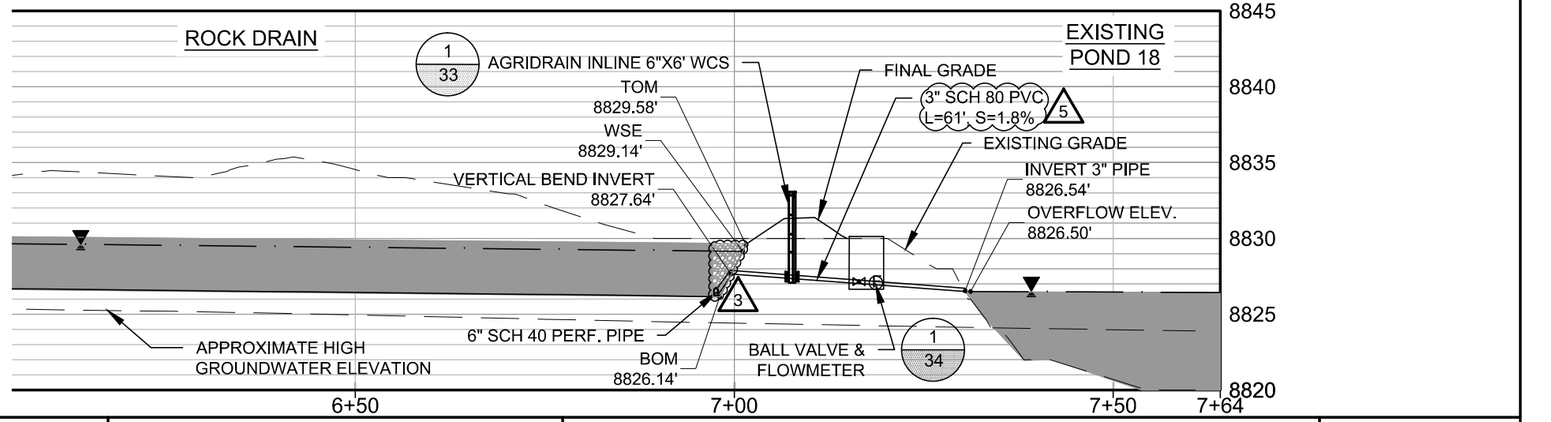
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

STORM DRAIN PLAN AND PROFILE

DATE: 05/31/13
SCALE: 1" = 40'
SHEET: 19 OF 42
PROJ No: SA11161315
19





NOTES:

1. PIPE LENGTHS AND SLOPES ARE APPROXIMATE. PIPES SHOULD BE FIELD FIT TO MATCH THE PROPOSED GRADES AND ALIGNMENT. MINIMUM PIPE SLOPE = 1.0%.
2. SEE OUTFALL PLAN FOR OUTLET EROSION PROTECTION.
3. SEE TRENCH DETAIL FOR INSULATION REQUIREMENTS FOR PIPE BURIED <6-FT DEEP.
4. PROFILE VERTICAL EXAGGERATION IS 2:1.
5. SEE DETAIL 2, SHEET 33 FOR TRENCH DETAIL.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
3	ADDENDUM 1	08/16/13	STA
5	ADDENDUM 3	09/06/13	STA

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DESIGNED KF
CHECKED CBF
REVIEWED RJB

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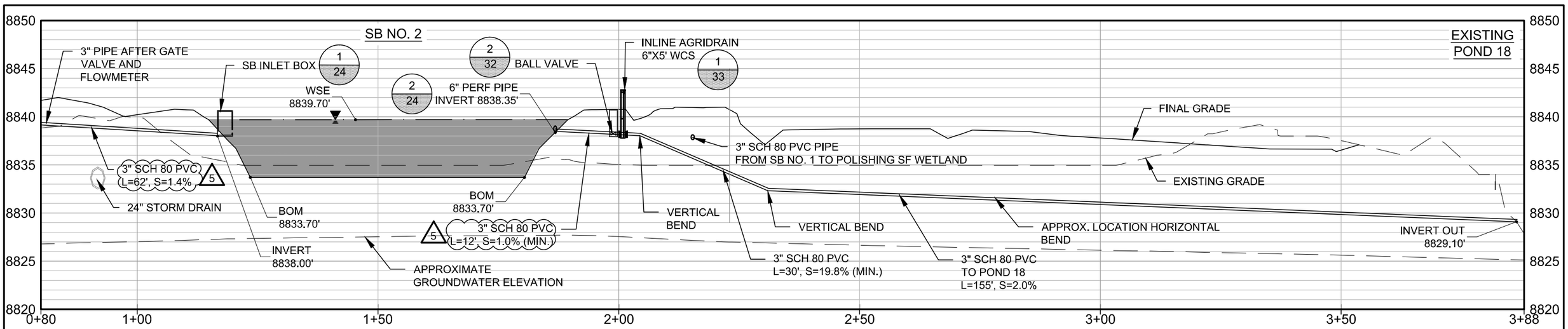
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

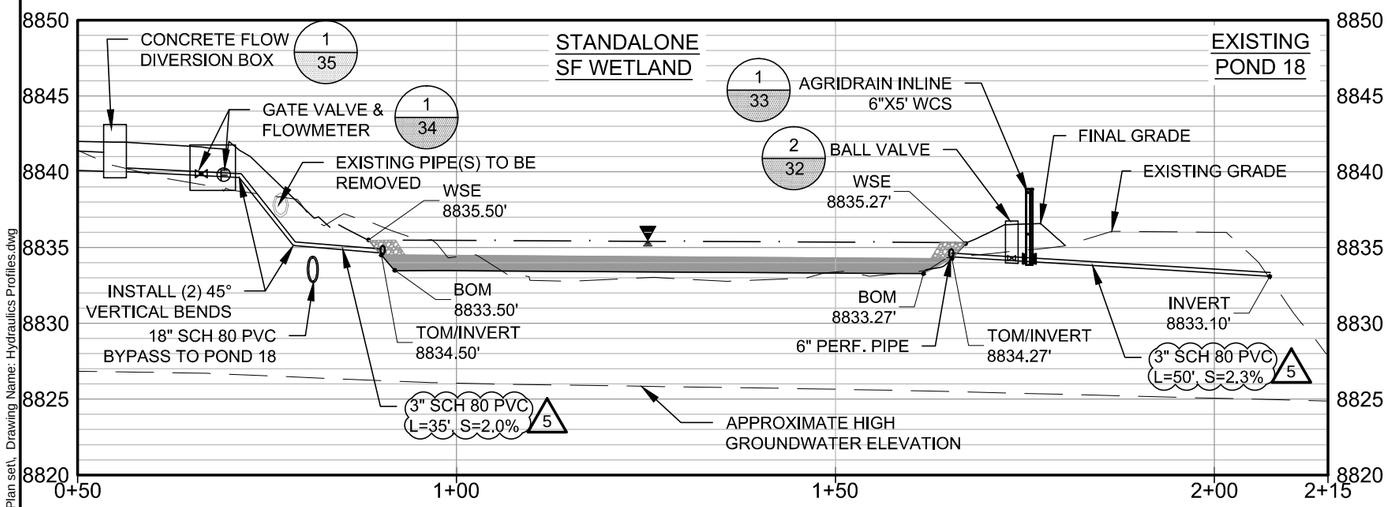
HYDRAULIC PROFILE - TREATMENT SYSTEM

DATE: 05/31/13
SCALE: 1" = 20'
SHEET: 20 OF 42
PROJ No: SA11161315
20

Plot Date: 09/11/13 - 5:41pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: Hydraulics Profiles.dwg



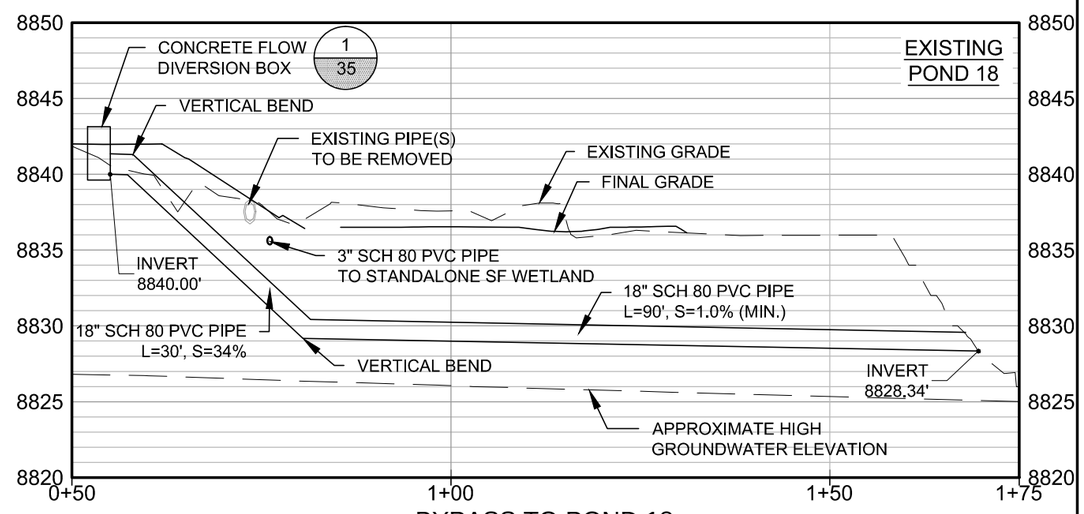
SB NO. 2 HYDRAULIC PROFILE



STANDALONE SF WETLAND HYDRAULIC PROFILE

NOTES:

1. PIPE LENGTHS AND SLOPES ARE APPROXIMATE. PIPES SHOULD BE FIELD FIT TO MATCH THE PROPOSED GRADES AND ALIGNMENT. MINIMUM PIPE SLOPE = 1.0%.
2. SEE OUTFALL PLAN FOR OUTLET EROSION PROTECTION.
3. SEE TRENCH DETAIL FOR INSULATION REQUIREMENTS FOR PIPE BURIED <6-FT DEEP.
4. PROFILE VERTICAL EXAGGERATION IS 2:1.
5. SEE DETAIL 2, SHEET 33 FOR TRENCH DETAIL.



BYPASS TO POND 18

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
5	ADDENDUM 3	09/06/13	STA

DRAWN KF
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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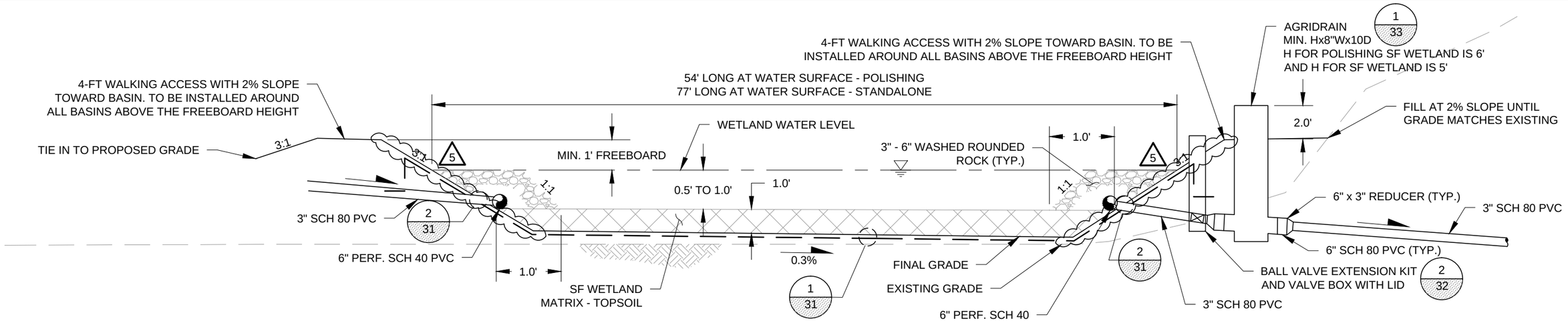
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

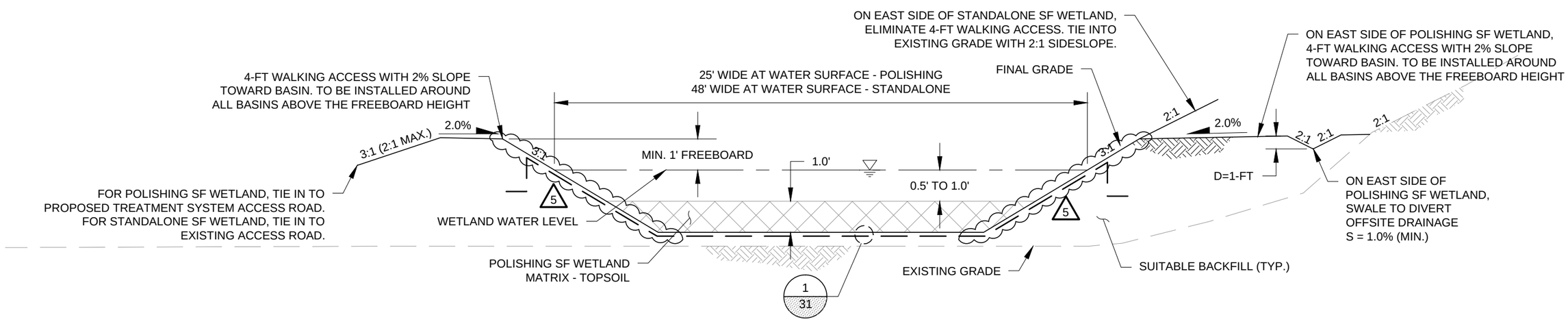
HYDRAULIC PROFILE- SB NO.2, STANDALONE SF WETLAND, BYPASS TO POND 18

DATE: 05/31/13
SCALE: 1" = 20'
SHEET: 21 OF 42
PROJ No: SA11161315
21

Plot Date: 09/11/13 - 5:41pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: Hydraulics Profiles.dwg



A 10,13 SURFACE FLOW WETLAND TYPICAL PROFILE SECTION



B 10,13 SURFACE FLOW WETLAND TYPICAL CROSS SECTION

NOTE:
SURFACE FLOW WETLAND TO BE PLANTED WITH SEDGES HARVESTED FROM AN ON-SITE LOCATION TO BE DETERMINED BY THE ENGINEER. SEDGES TO BE PLANTED 1.5 FT O.C.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
3	ADDENDUM 1	08/16/13	STA
5	ADDENDUM 3	09/06/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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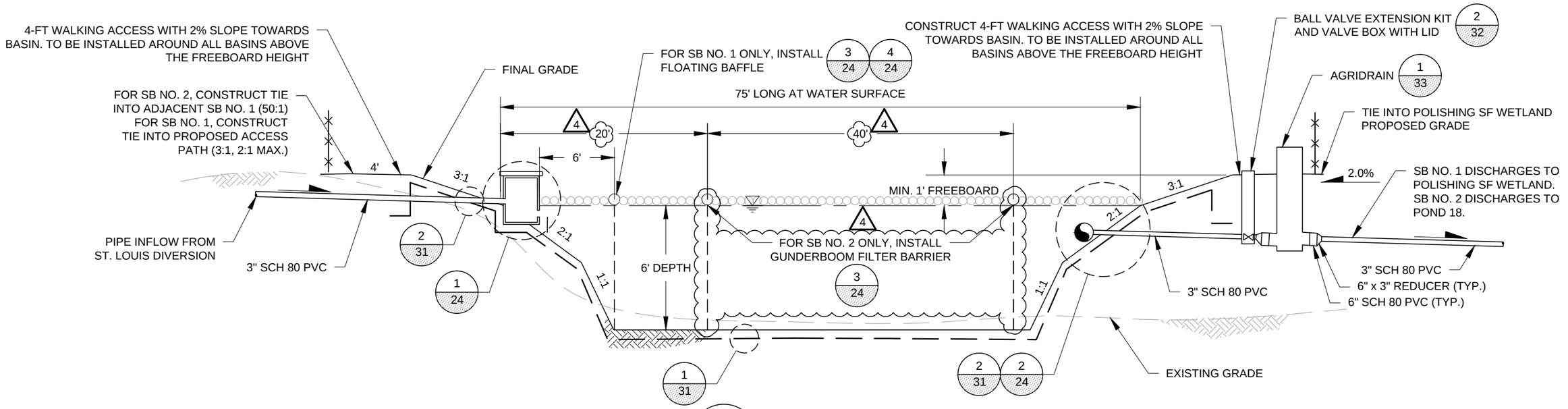
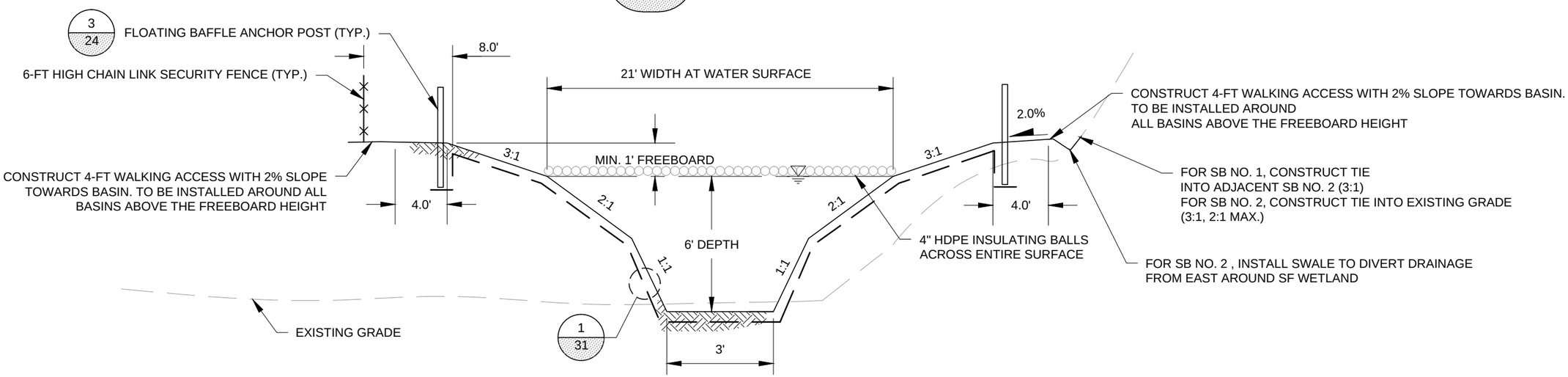
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

POLISHING AND STANDALONE 3
SURFACE FLOW WETLANDS SECTIONS

DATE: 05/31/13
SCALE: NTS
SHEET: 22 OF 42
PROJ No: SA11161315
22



A 11,12 SETTLING BASIN TYPICAL PROFILE SECTION



B 11,12 SETTLING BASIN TYPICAL CROSS SECTION

NOTE:
4 1. INSTALLATION OF FLOATING BAFFLE AND GUNDERBOOM SHALL BE IN ACCORDANCE WITH MANUFACTURERS' SPECIFICATIONS AND RECOMMENDATIONS.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
4	ADDENDUM 2	08/23/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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Rancho Cordova, CA 95670
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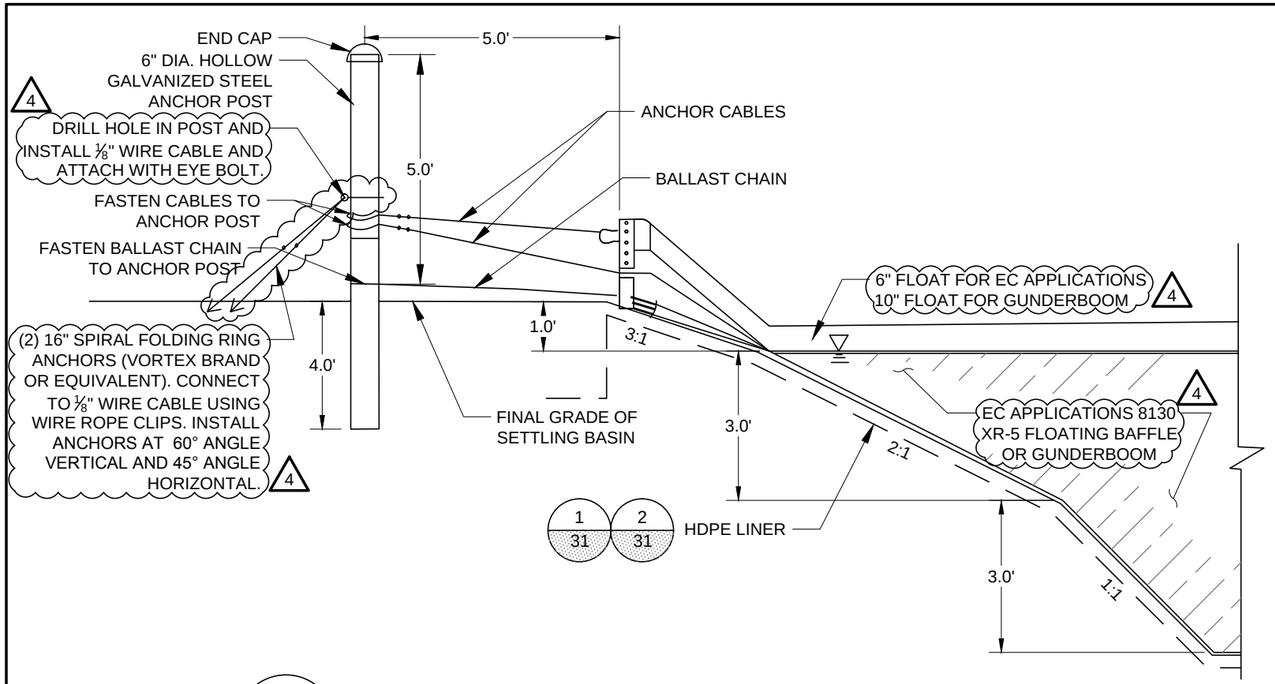
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

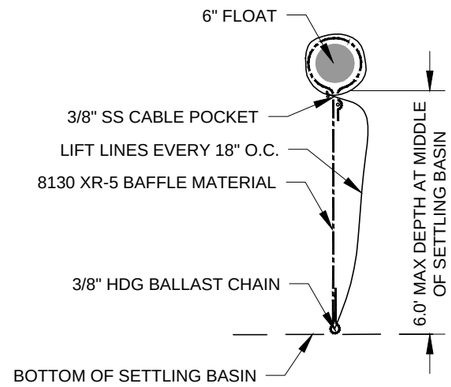
SETTLING BASINS NO. 1 & NO. 2 TYPICAL SECTIONS

DATE: 05/31/13
SCALE: NTS
SHEET: 23 OF 42
PROJ No: SA11161315
23

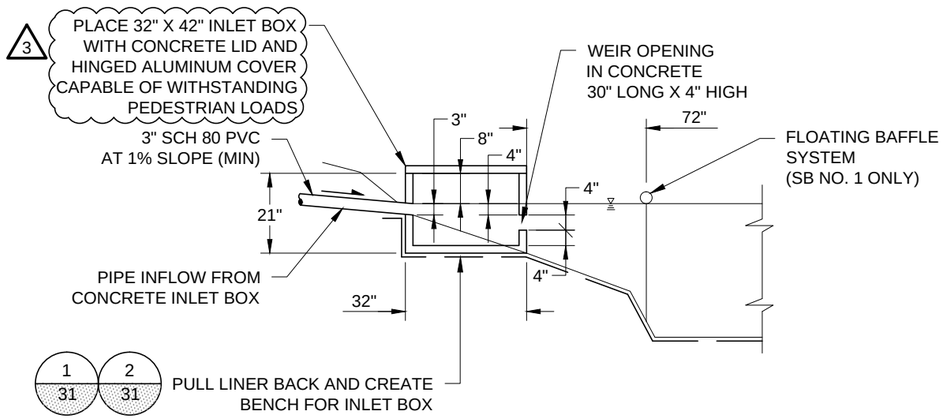
Plot Date: 09/11/13 - 5:41pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: Settling Basin 1-2 sections.dwg



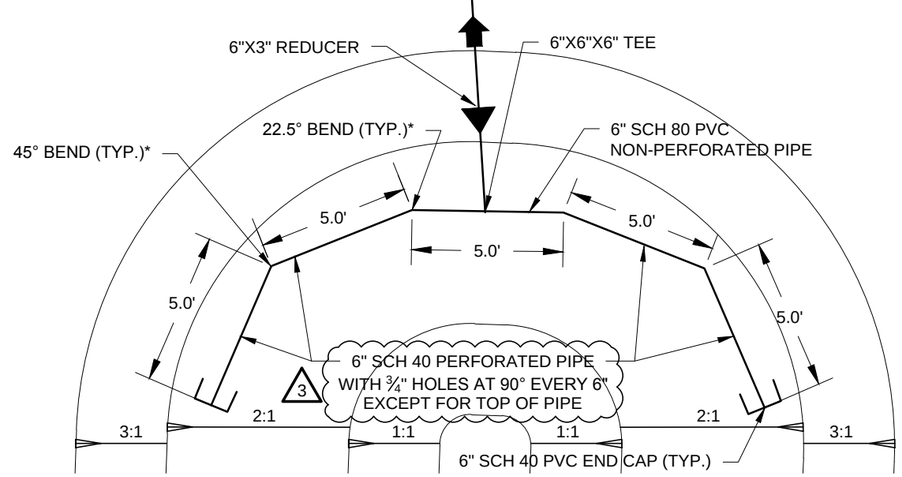
3 11,12,23 SETTLING BASIN FLOATING BAFFLE PROFILE VIEW



4 12,23 SETTLING BASIN FLOATING BAFFLE SECTION VIEW



1 11,12,20,21,23 SETTLING BASIN NO. 1 AND NO. 2 INLET DETAIL



2 11,12,20,21,23 SETTLING BASIN NO. 1 AND NO. 2 OUTLET DETAIL

NOTE:
* FIELD FIT HORIZONTAL BENDS SO THAT PERFORATED PIPE CONTOURS ALONG POND AND IS SUPPORTED BY POND SIDESLOPE.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
3	ADDENDUM 1	08/16/13	STA
4	ADDENDUM 2	08/23/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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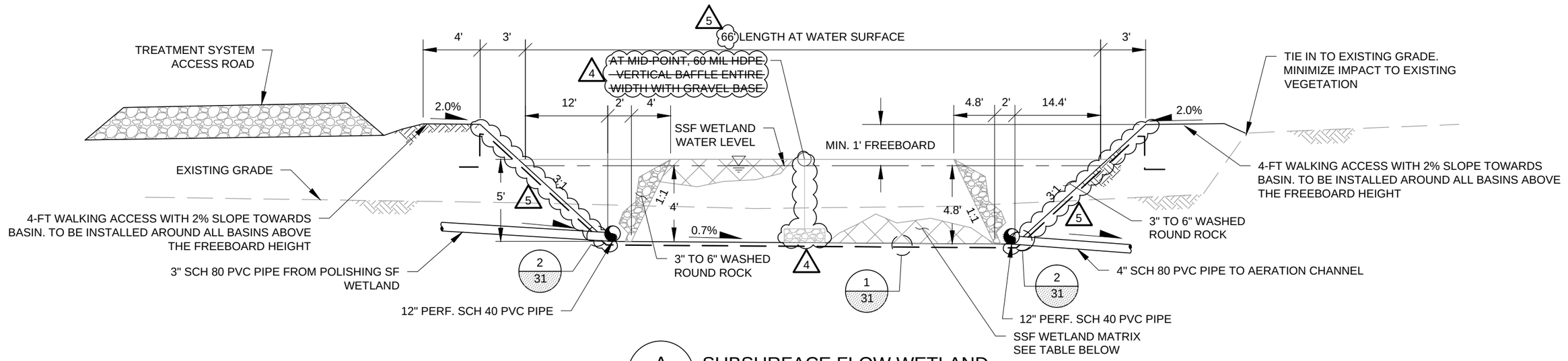
Rancho Cordova, CA 95670
(916) 636-3200

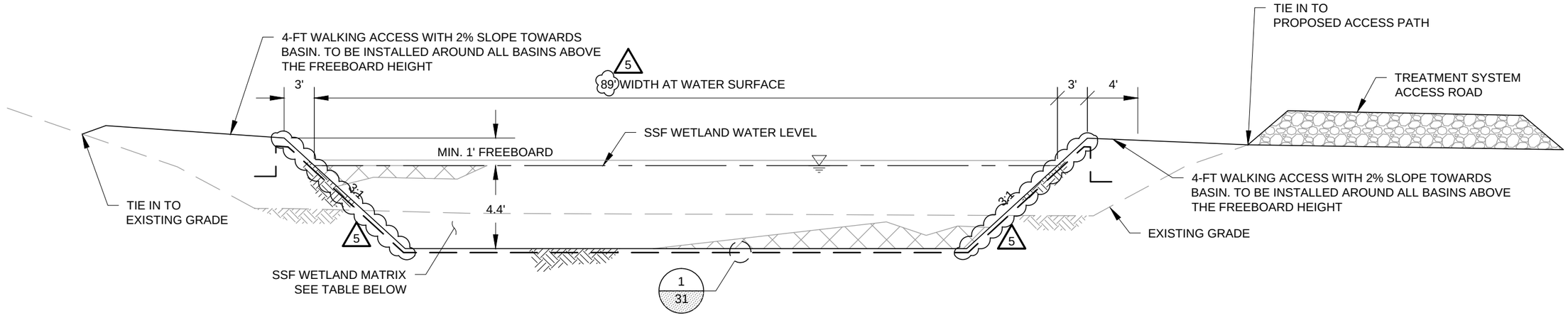
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

SETTLING BASINS NO. 1 & NO. 2 DETAILS

DATE: 05/31/13
SCALE: NTS
SHEET: 24 OF 42
PROJ No: SA11161315
24



A 14 SUBSURFACE FLOW WETLAND TYPICAL PROFILE SECTION



B 14 SUBSURFACE FLOW WETLAND TYPICAL CROSS SECTION

SSF WETLAND MATRIX

MATERIALS	%
1.5" WASHED ROUNDED ROCK	60
1" - 2" WOOD CHIPS	35
MANURE	4.6
SULFUR PRILL	0.38
LIQUID FISH FERTILIZER	0.02

NOTE:
SUBSURFACE FLOW WETLAND TO BE PLANTED WITH CATTAILS HARVESTED FROM AN ON-SITE LOCATION DETERMINED BY ENGINEER. CATTAIL TUBER PLANT SPACING TO BE 1.5-FT O.C.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
4	ADDENDUM 2	08/23/13	STA
5	ADDENDUM 3	09/06/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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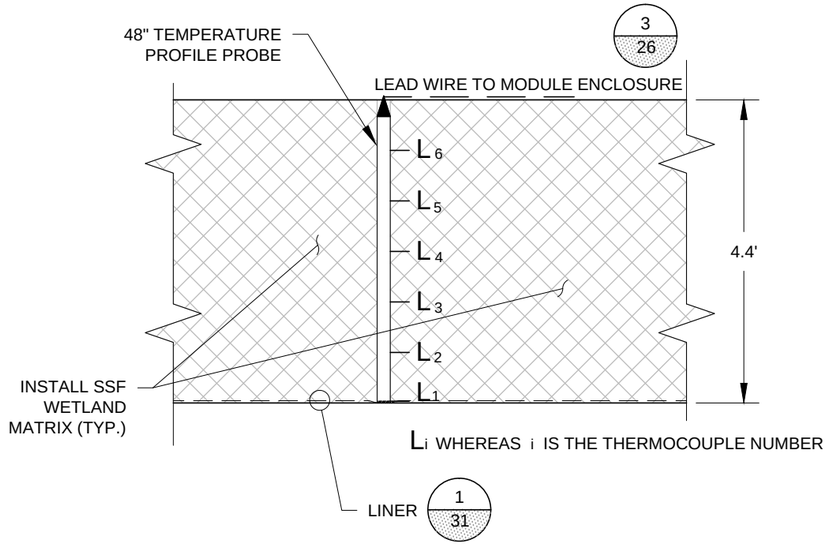
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

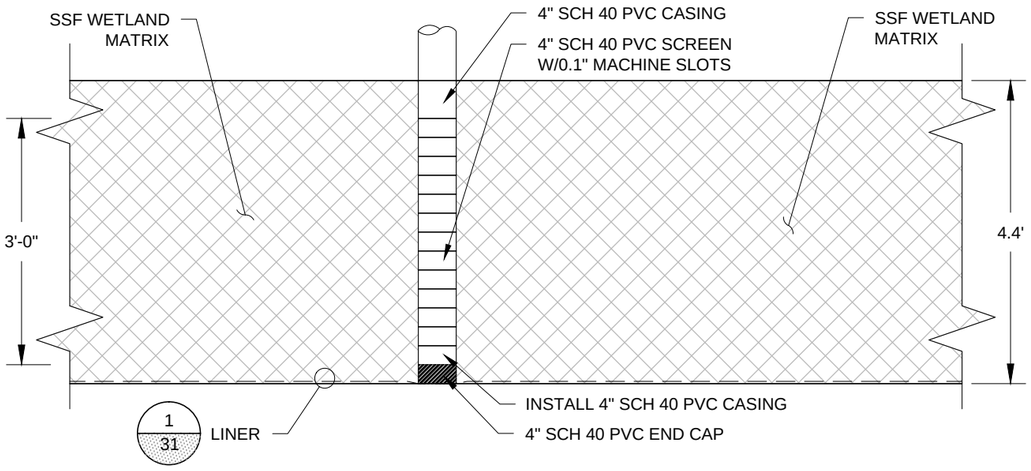
SUBSURFACE FLOW WETLAND SECTIONS

DATE: 05/31/13
SCALE: NTS
SHEET: 25 OF 42
PROJ No: SA11161315
25

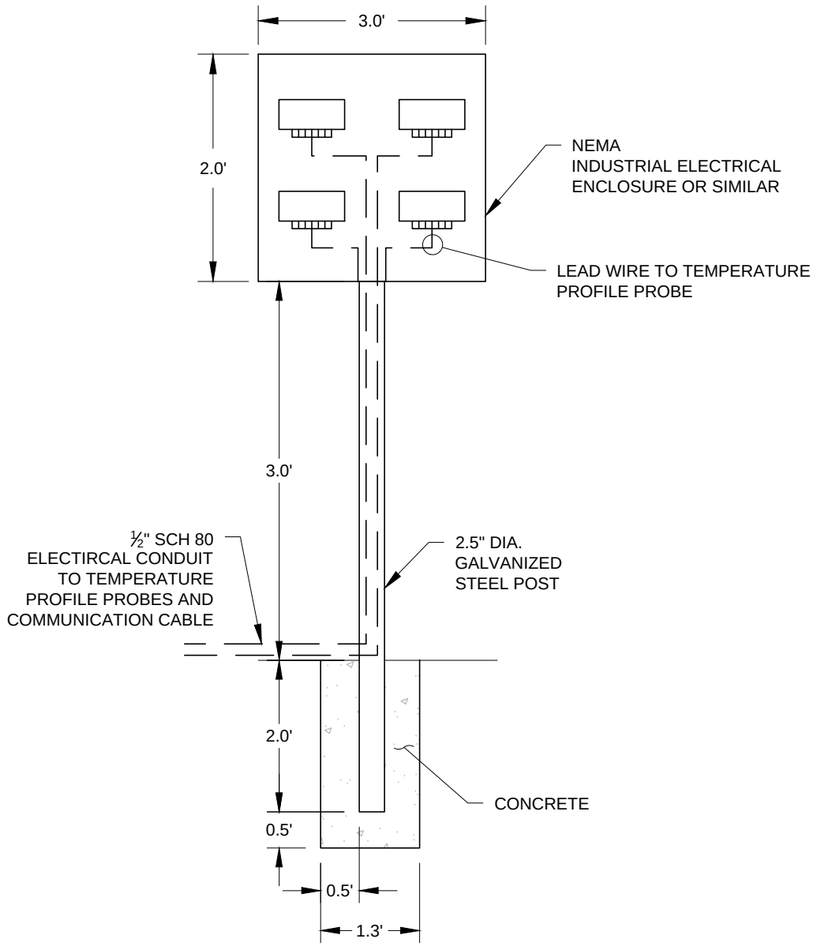
Plot Date: 09/11/13 - 5:42pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: SSF Wetland sections.dwg



1 / 9,14 SSF WETLAND TEMPERATURE PROFILE PROBE DETAIL



2 / 9,14 SSF WETLAND TEMPERATURE MONITORING PORT DETAIL



3 / 26 SSF WETLAND TEMPERATURE PROBE MODULE ENCLOSURE AND POST DETAIL

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA

DRAWN DWW
DESIGNED ARC
CHECKED CBF
REVIEWED RJB

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10670 White Rock Road , Suite 100
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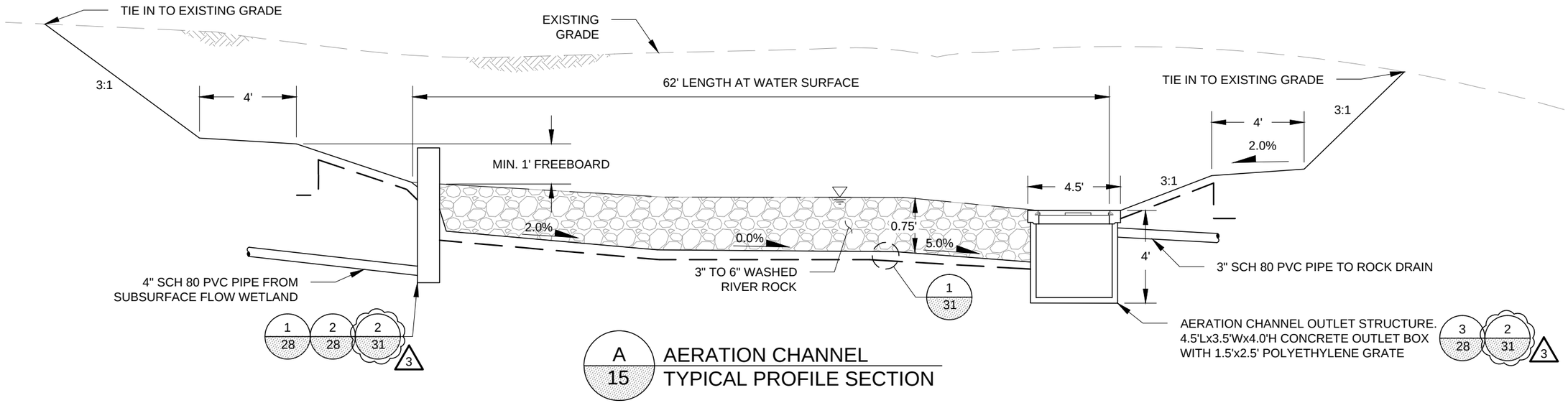
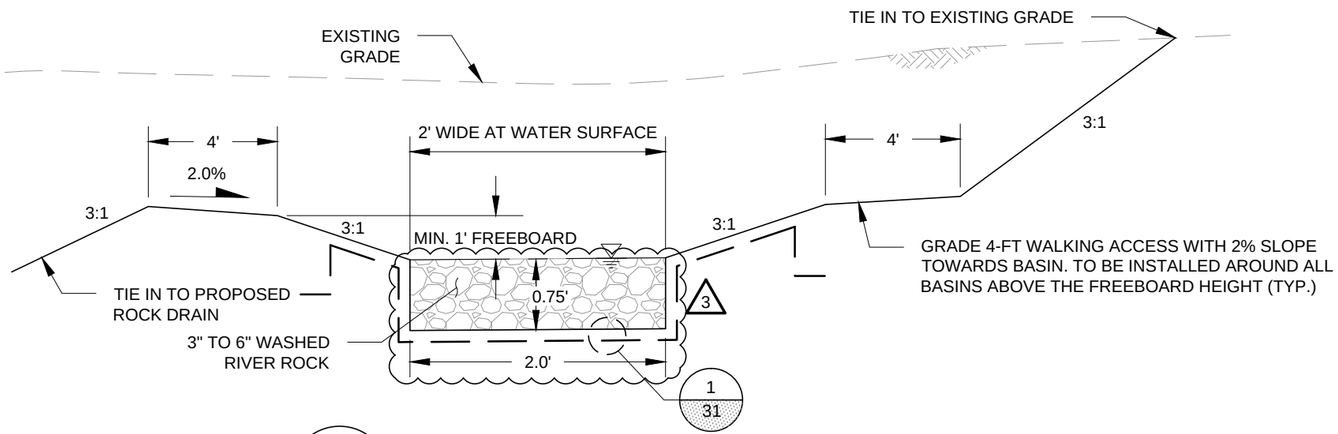
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

SUBSURFACE FLOW WETLAND DETAILS

DATE: 05/31/13
SCALE: NTS
SHEET: 26 OF 42
PROJ No: SA11161315
26



A/15 AERATION CHANNEL TYPICAL PROFILE SECTION



B/15 AERATION CHANNEL TYPICAL CROSS SECTION

NOTE: 3
PROVIDE HDPE BOOT AROUND INLET AND OUTLET STRUCTURES AS PER THE PIPE PENETRATION DETAIL.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
3	ADDENDUM 1	08/16/13	STA

DRAWN MGC
DESIGNED KF
CHECKED CBF
REVIEWED RJB

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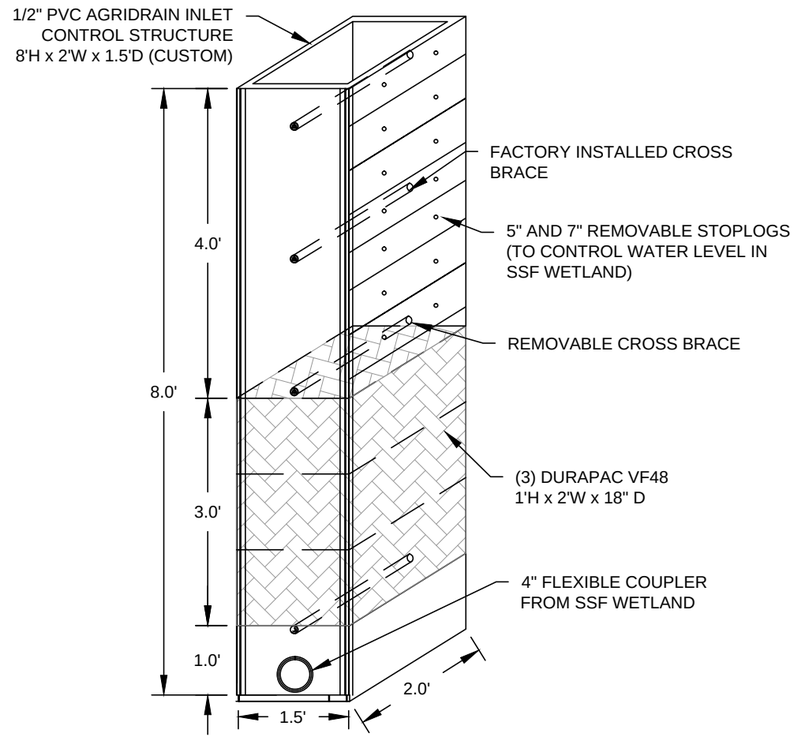
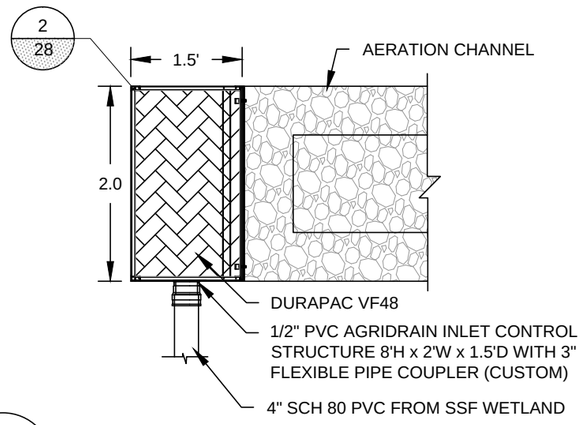
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

AERATION CHANNEL SECTIONS

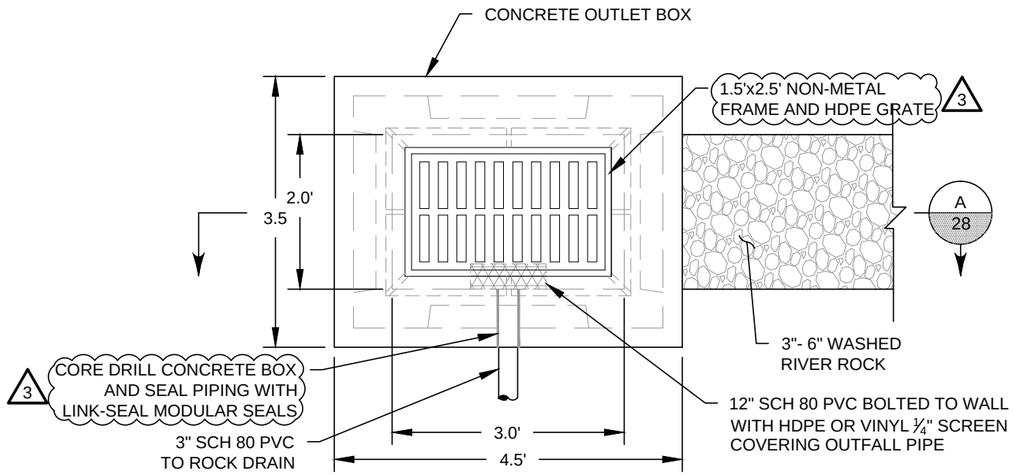
DATE: 05/31/13
SCALE: NTS
SHEET: 27 OF 42
PROJ No: SA11161315
27



2 / 15,20,27,28 AERATION CHANNEL INLET STRUCTURE
ISOMETRIC VIEW



1 / 15,20,27 AERATION CHANNEL INLET STRUCTURE
PLAN VIEW



3 / 15,20,27 AERATION CHANNEL OUTLET STRUCTURE
PLAN VIEW

A / 28 AERATION CHANNEL OUTLET STRUCTURE
PROFILE VIEW

REFERENCES:	NO.	REVISION	DATE	APRVD
PLANS	1	ISSUED FOR REVIEW	05/31/13	STA
	2	ISSUED FOR CONSTRUCTION	06/28/13	STA
DATUM	3	ADDENDUM 1	08/16/13	STA

DRAWN MGC
DESIGNED ARC
CHECKED CBF
REVIEWED RJB

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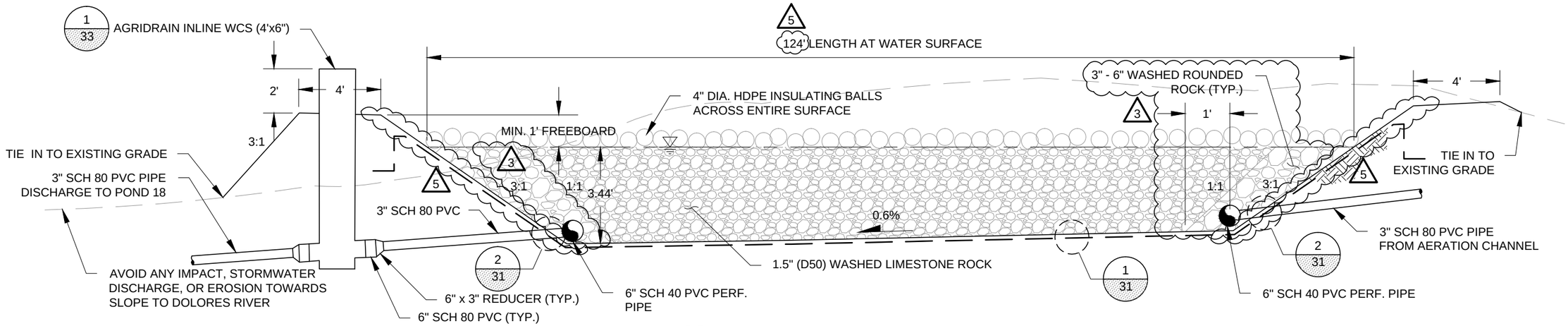
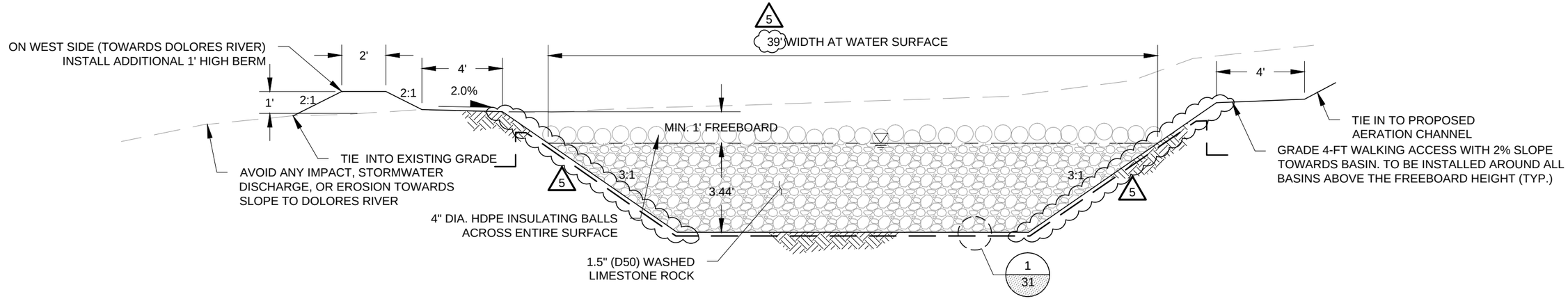
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

AERATION CHANNEL DETAILS

DATE: 05/31/13
SCALE: NTS
SHEET: 28 OF 42
PROJ No: SA11161315
28



A 15,16 ROCK DRAIN
TYPICAL PROFILE SECTION



B 15,16 ROCK DRAIN
TYPICAL CROSS SECTION

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
3	ADDENDUM 1	08/16/13	STA
5	ADDENDUM 3	09/06/13	STA

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CHECKED CBF
REVIEWED RJB

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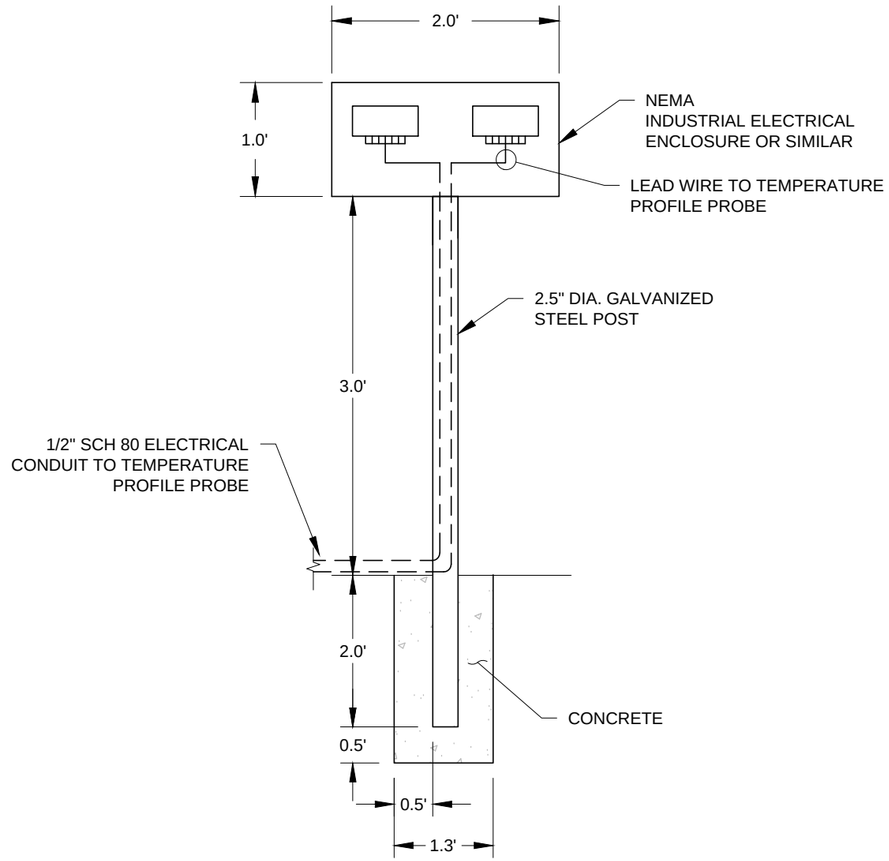
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

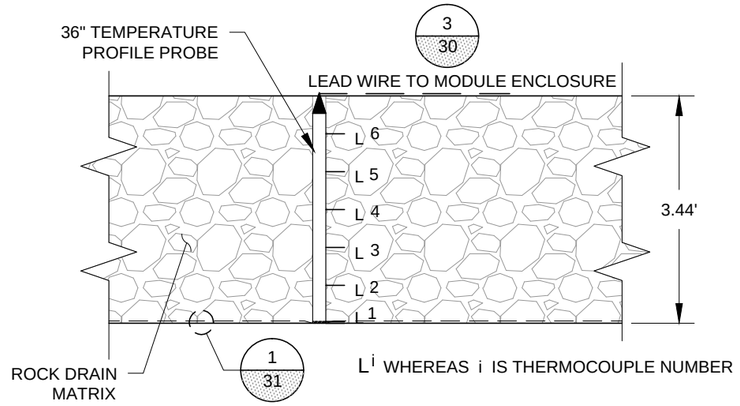
ROCK DRAIN SECTIONS

DATE: 05/31/13
SCALE: NTS
SHEET: 29 OF 42

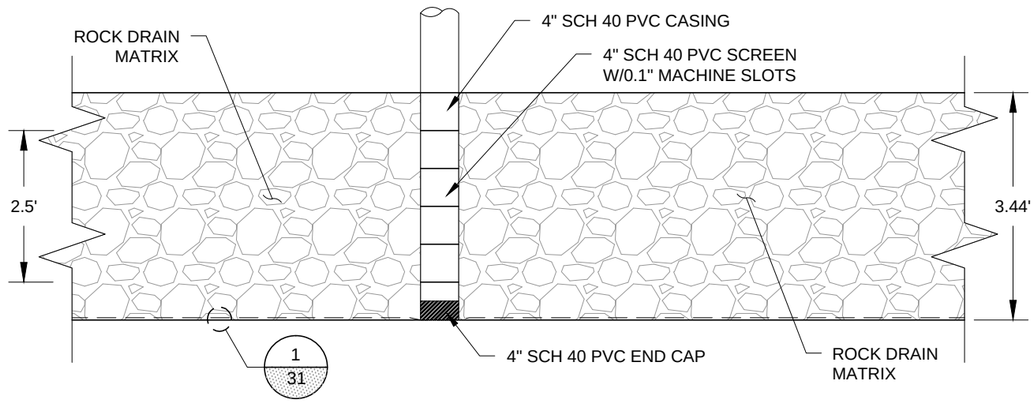
PROJ No: SA11161315



3 / 9,30 ROCK DRAIN TEMPERATURE PROBE MODULE ENCLOSURE AND POST DETAIL



1 / 9,15,16 ROCK DRAIN TEMPERATURE PROFILE PROBE INSTALLATION DETAIL



2 / 9,15,16 ROCK DRAIN MONITORING PORT INSTALLATION DETAIL

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
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RICO - ARGENTINE MINE SITE
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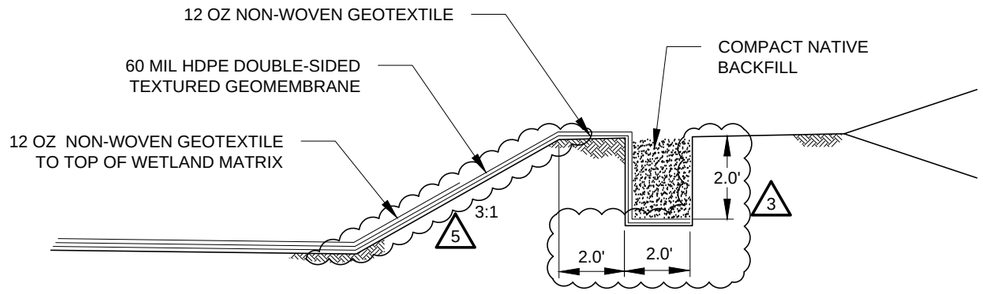
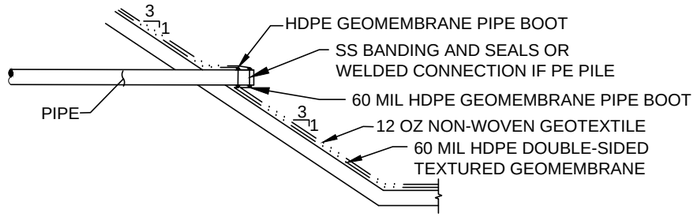
ROCK DRAIN DETAILS

DATE: 05/31/13
SCALE: NTS
SHEET: 30 OF 42
PROJ No: SA11161315
30



1 22,23,24,25,26,27,29,30,32 LINER DETAIL



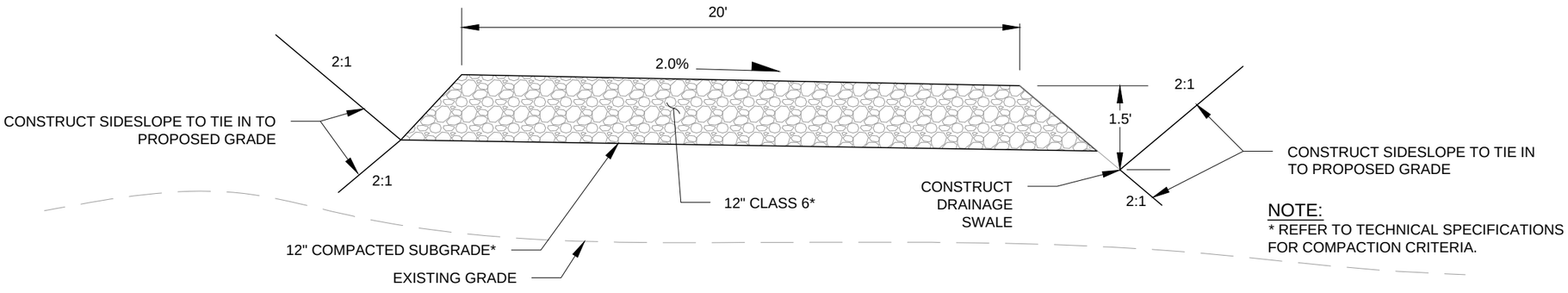
NOTES:

1) PANELS AROUND PIPING PENETRATIONS OR OTHER PROJECTIONS THROUGH THE PANEL SHOULD BE CUT WITH ROUNDED CORNERS TO PREVENT TEAR PROPAGATIONS.

2) ALL GEOMEMBRANE BOOTS AND SHROUDS SHOULD BE OF THE SAME MATERIAL AND THICKNESS AS THE GEOMEMBRANE SPECIFIED FOR THE PROJECT.

3) ALL BOOTS SHOULD FIT SNUGLY WITHOUT WRINKLES OR 'FISHMOUTHS'

2 22,23,24,25,27,29 (3) PIPE PENETRATION DETAIL



NOTE:

* REFER TO TECHNICAL SPECIFICATIONS FOR COMPACTION CRITERIA.

A 18 TREATMENT SYSTEM ACCESS ROAD TYPICAL SECTION

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
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RICO - ARGENTINE MINE SITE
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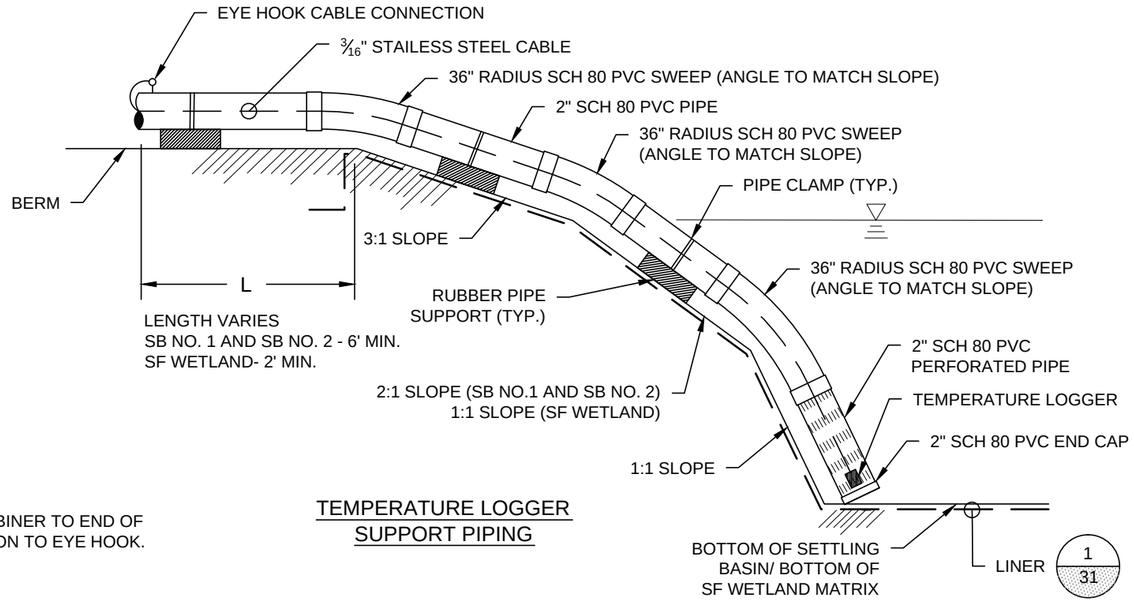
SECTIONS AND DETAILS SHEET
(SHEET 1 OF 6)

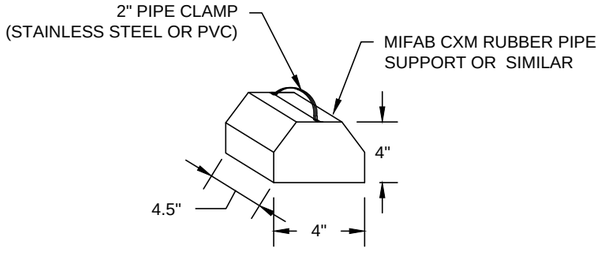
DATE: 05/31/13
SCALE: NTS
SHEET: 31 OF 42
PROJ No: SA11161315
31

Plot Date: 09/11/13 - 5:43pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: General Sections.dwg



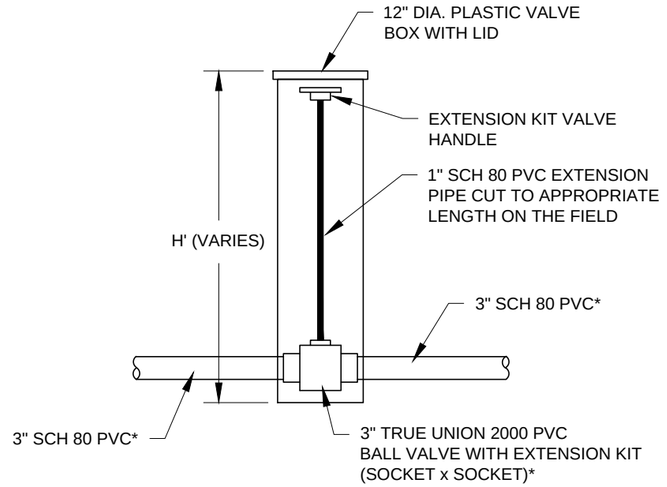
NOTE:
1. SWEDGE SMALL CARABINER TO END OF CABLE FOR CONNECTION TO EYE HOOK.

TEMPERATURE LOGGER SUPPORT PIPING



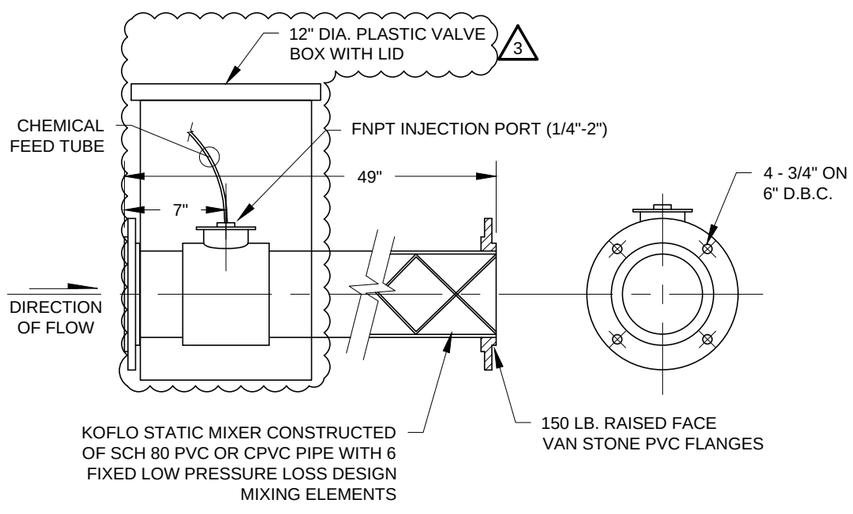
RUBBER PIPE SUPPORT

1 / 9,10,12,13 — TEMPERATURE LOGGER INSTALLATION DETAIL



* TO BE 4" SCH 80 PVC AND 4" BALL VALVE DOWNSTREAM OF SSF WETLAND.

2 / 10,11,13,14,15,17,20,21,22,23 — BALL VALVE WITH EXTENSION KIT AND VALVE BOX WITH LID DETAIL



3 / 12,20 — STATIC MIXER DETAIL

REFERENCES:	NO.	REVISION	DATE	APRVD
PLANS	1	ISSUED FOR REVIEW	05/31/13	STA
	2	ISSUED FOR CONSTRUCTION	06/28/13	STA
DATUM	3	ADDENDUM 1	08/16/13	STA

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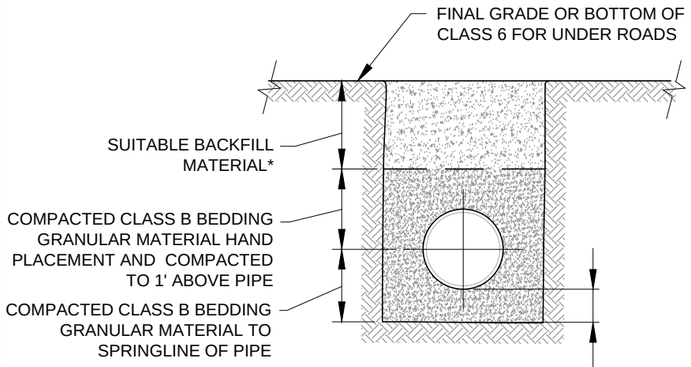
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

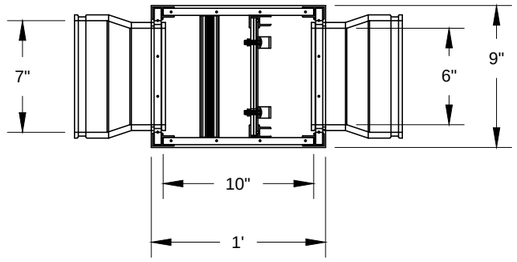
SECTIONS AND DETAILS SHEET
(SHEET 2 OF 6)

DATE: 05/31/13
SCALE: NTS
SHEET: 32 OF 42
PROJ No: SA11161315
32

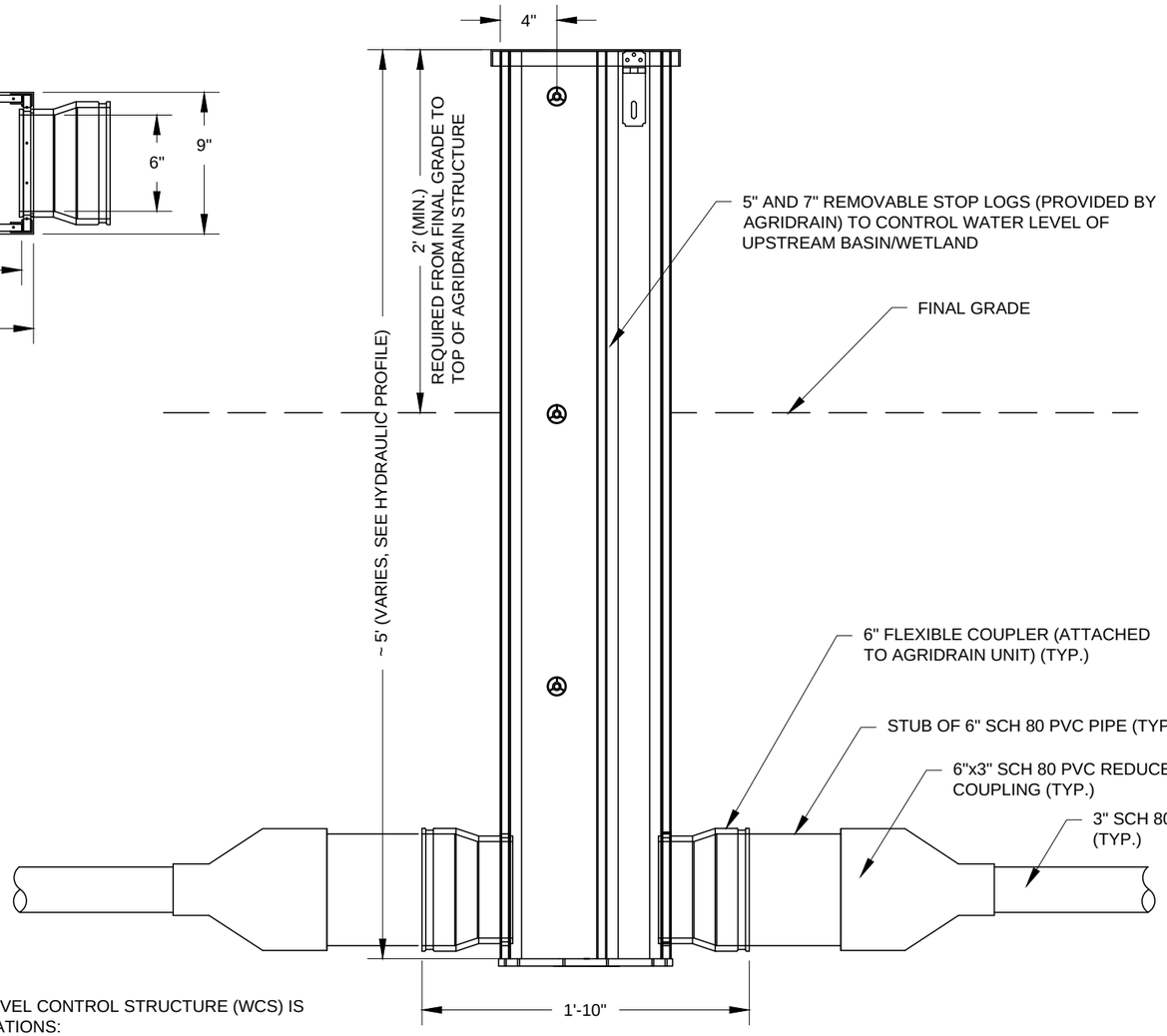


BACKFILL DETAIL

NOTE:
* SEE TECHNICAL SPECIFICATIONS FOR COMPACTION CRITERIA

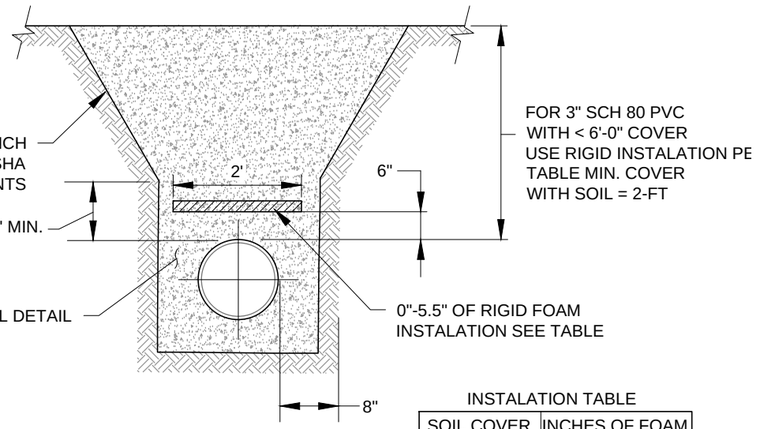


PLAN VIEW



SECTION VIEW

1 AGRIDRAIN INLINE WCS
9,10,11,13,16,17,20,21,22,23,29



TRENCH SHAPE DETAIL

INSTALATION TABLE

SOIL COVER	INCHES OF FOAM
2-FT	5.5"
3-FT	4.0"
4-FT	2.5"
5-FT	1.5"
6-FT	0"

2 TRENCH DETAIL

NOTES:
THE AGRIDRAIN INLINE WATER LEVEL CONTROL STRUCTURE (WCS) IS TO BE INSTALLED IN (5) FIVE LOCATIONS:
1. DOWNSTREAM OF THE POLISHING SF WETLAND TO CONTROL WATER LEVEL IN THE POLISHING SURFACE WETLAND
2. DOWNSTREAM OF THE ROCK DRAIN TO CONTROL WATER LEVEL IN THE ROCK DRAIN
3. DOWNSTREAM OF THE SF WETLAND TO CONTROL WATER LEVEL IN THE SF WETLAND
4. DOWNSTREAM OF THE SB NO. 1 TO CONTROL WATER LEVEL IN SB NO. 1
5. DOWNSTREAM OF THE SB NO. 2 TO CONTROL WATER LEVEL IN SB NO. 2

THE AGRIDRAIN INLET INCLUDES ONLY THE INLET PIPE. THIS UNIT IS PROPOSED UPSTREAM OF THE AERATION CHANNEL. SEE AERATION CHANNEL INLET DETAIL.

REFERENCES:
PLANS

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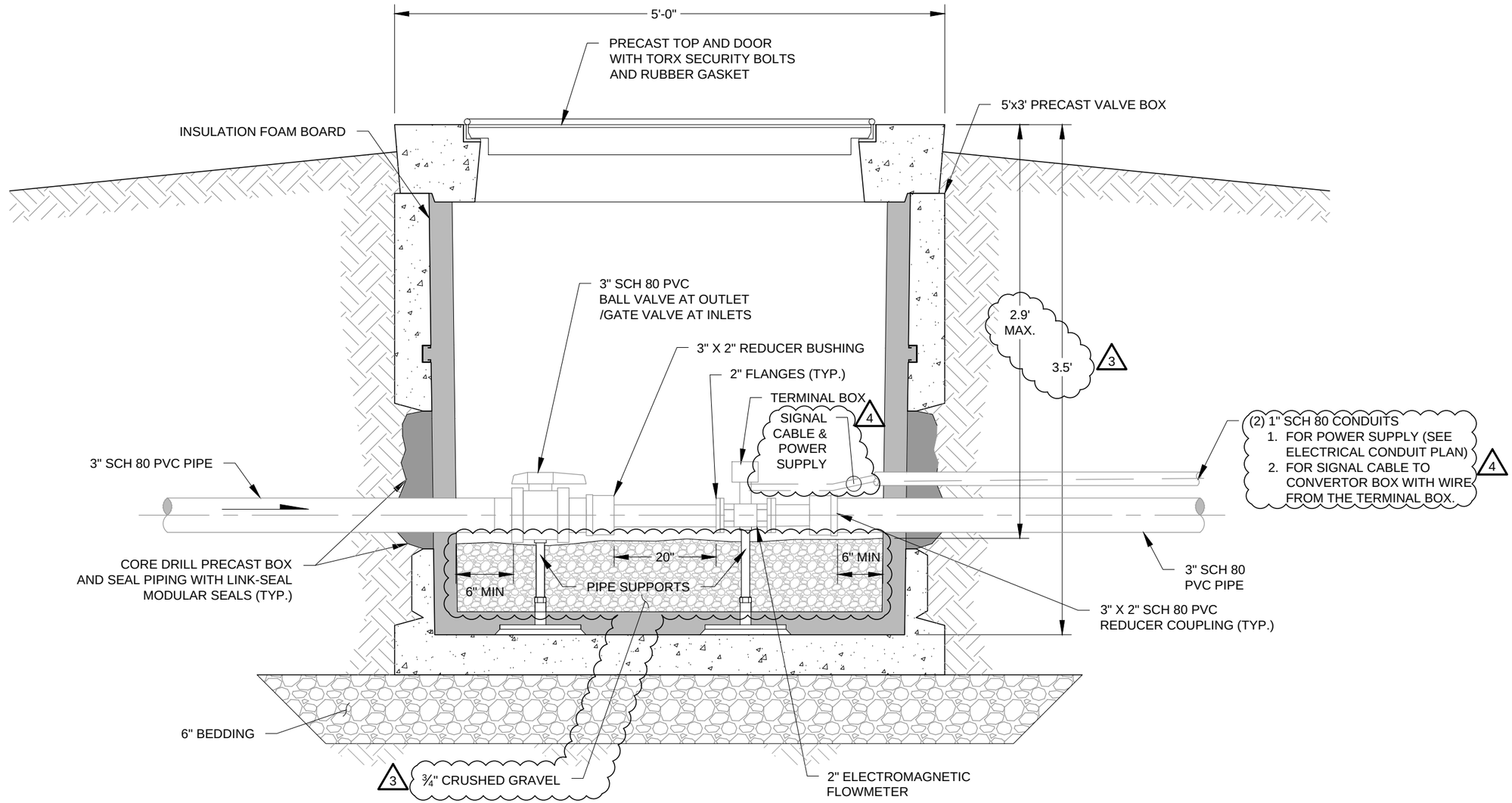
CONSTRUCTED WETLAND DEMONSTRATION

SECTIONS AND DETAILS SHEET (SHEET 3 OF 6)

DATE: 05/31/13
SCALE: NTS
SHEET: 33 OF 42
PROJ No: SA11161315
33



NOTES:

1. GATE VALVE TO BE INSTALLED WITH INFLUENT FLOWMETERS. BALL VALVE TO BE INSTALLED WITH EFFLUENT FLOWMETERS.
2. THE MINIMUM STRAIGHT PIPE LENGTH REQUIRED UPSTREAM OF THE INFLUENT FLOWMETERS 14-INCHES AND DOWNSTREAM OF THE FLOWMETER IS 4-INCHES.
3. FOR PIPE ELEVATION SEE HYDRAULIC PROFILE.
4. POWER SUPPLY AND SIGNAL CABLE SHALL BE VENDOR SUPPLIED. 4

1 — 9,10,12,16,20,21 — VALVE BOX DETAIL

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
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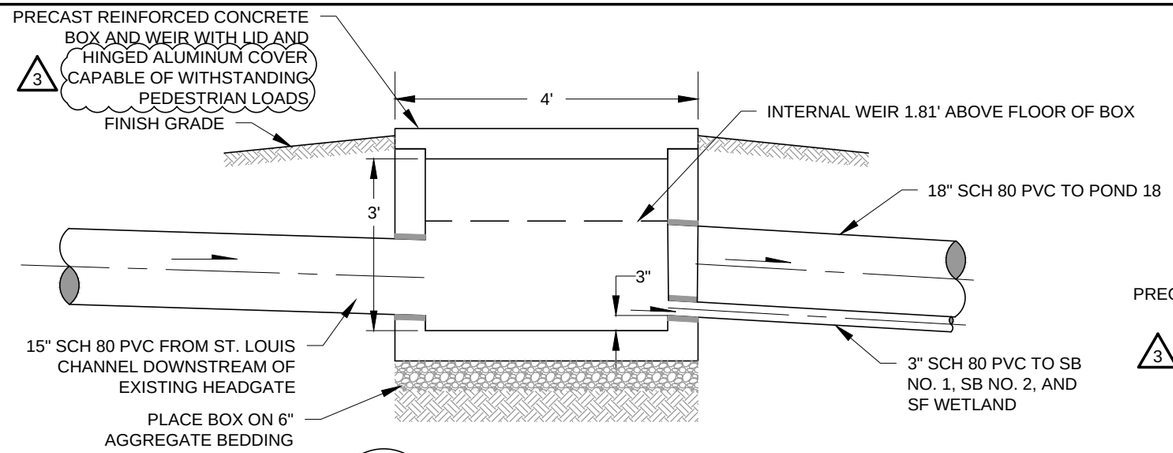
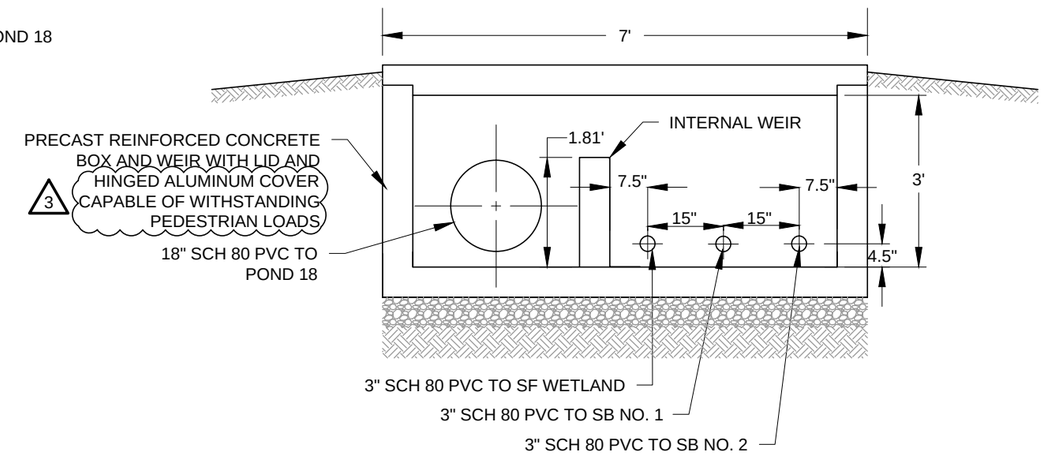
SECTIONS AND DETAILS SHEET
(SHEET 4 OF 6)

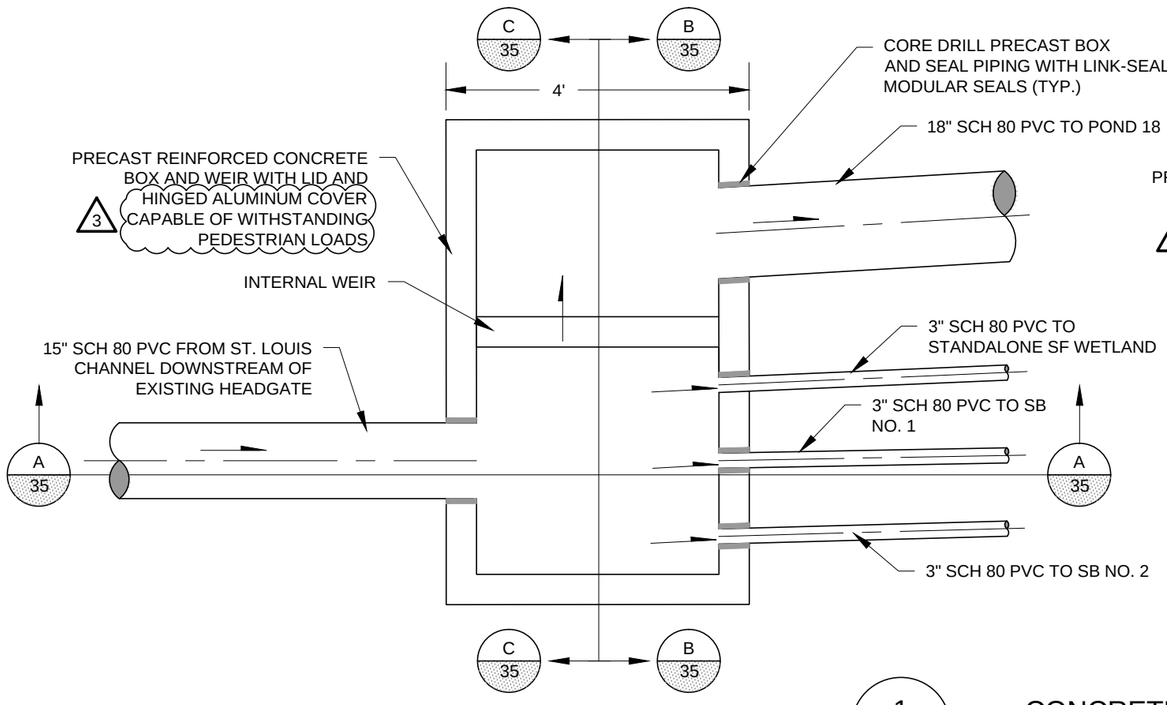
DATE: 05/31/13
SCALE: NTS
SHEET: 34 OF 42
PROJ No: SA11161315
34



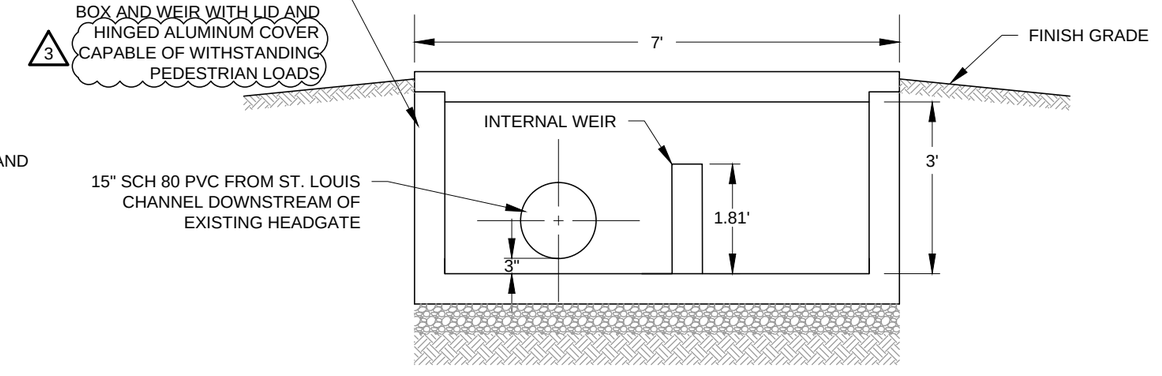
A 35 CONCRETE INLET BOX



B 35 CONCRETE INLET BOX



1 10,20,21 CONCRETE FLOW DIVERSION BOX PLAN VIEW



C 35 CONCRETE INLET BOX

NOTES:
1. ALL INVERTS IN AND OUT ARE 8840.00.
3 2. CORE DRILL PRECAST BOX AND SEAL PIPING WITH LINK-SEAL MODULAR SEALS (TYP.).

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
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3	ADDENDUM 1	08/16/13	STA

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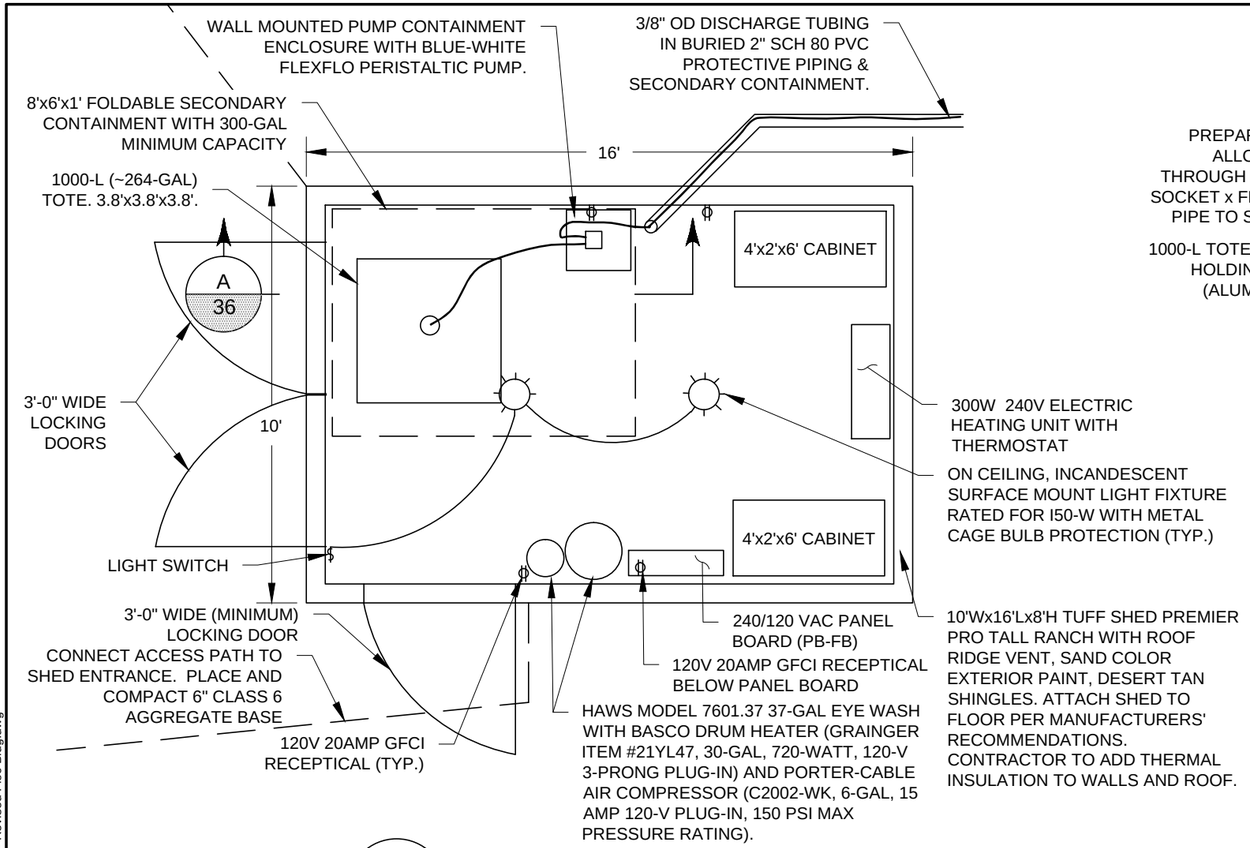
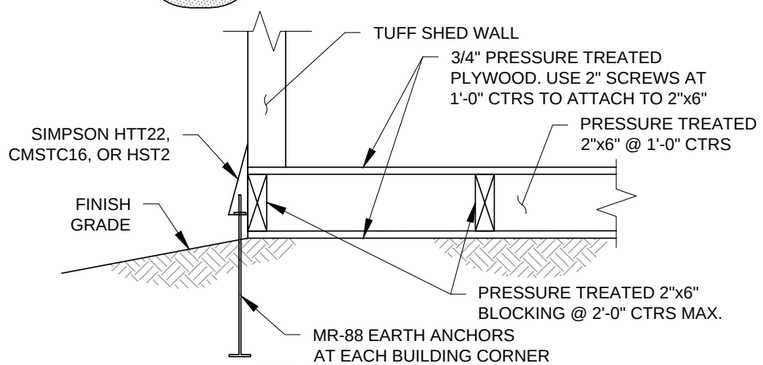
CONSTRUCTED WETLAND DEMONSTRATION

SECTIONS AND DETAILS SHEET (SHEET 5 OF 6)

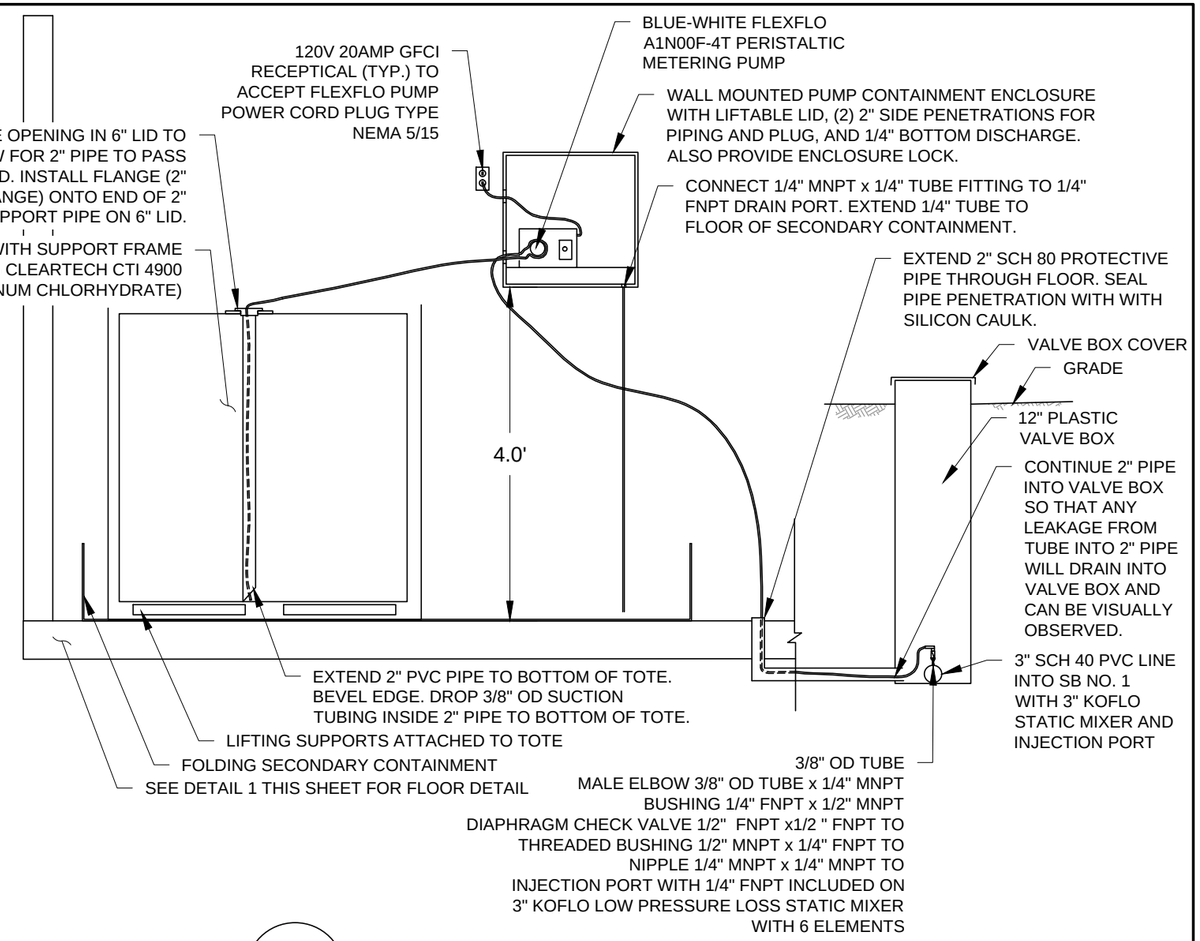
DATE: 05/31/13
SCALE: NTS
SHEET: 35 OF 42
PROJ No: SA11161315
35



1 / 12,17 CHEMICAL FEED BUILDING PLAN VIEW



1 / 36 CHEMICAL FEED BUILDING FLOOR DETAIL



A / 36 CHEMICAL FEED BUILDING ELEVATION VIEW

NOTES:
1. PLACE 1000-L TOTE IN BUILDING USING FORK LIFT OR EQUIVALENT TO PLACE TOTE IN SECONDARY CONTAINMENT FROM OUTSIDE BUILDING.
2. ALL ELECTRICAL EQUIPMENT SHALL BE OUTDOOR RATED, GROUND PROTECTED, AND SPLASH PROOF.
3. SUCTION TUBING SHALL BE 3/8" OD CLEAR PVC TUBING IN A CONTINUOUS LENGTH (NO FITTINGS) BETWEEN THE BOTTOM OF THE TOTE AND TO THE INSIDE OF THE PUMP CONTAINMENT ENCLOSURE.
4. DISCHARGE TUBING SHALL BE 3/8" OD LLDPE TUBING IN A CONTINUOUS LENGTH (NO FITTINGS) BETWEEN THE PUMP CONTAINMENT ENCLOSURE AND THE FLOOR PENETRATION.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
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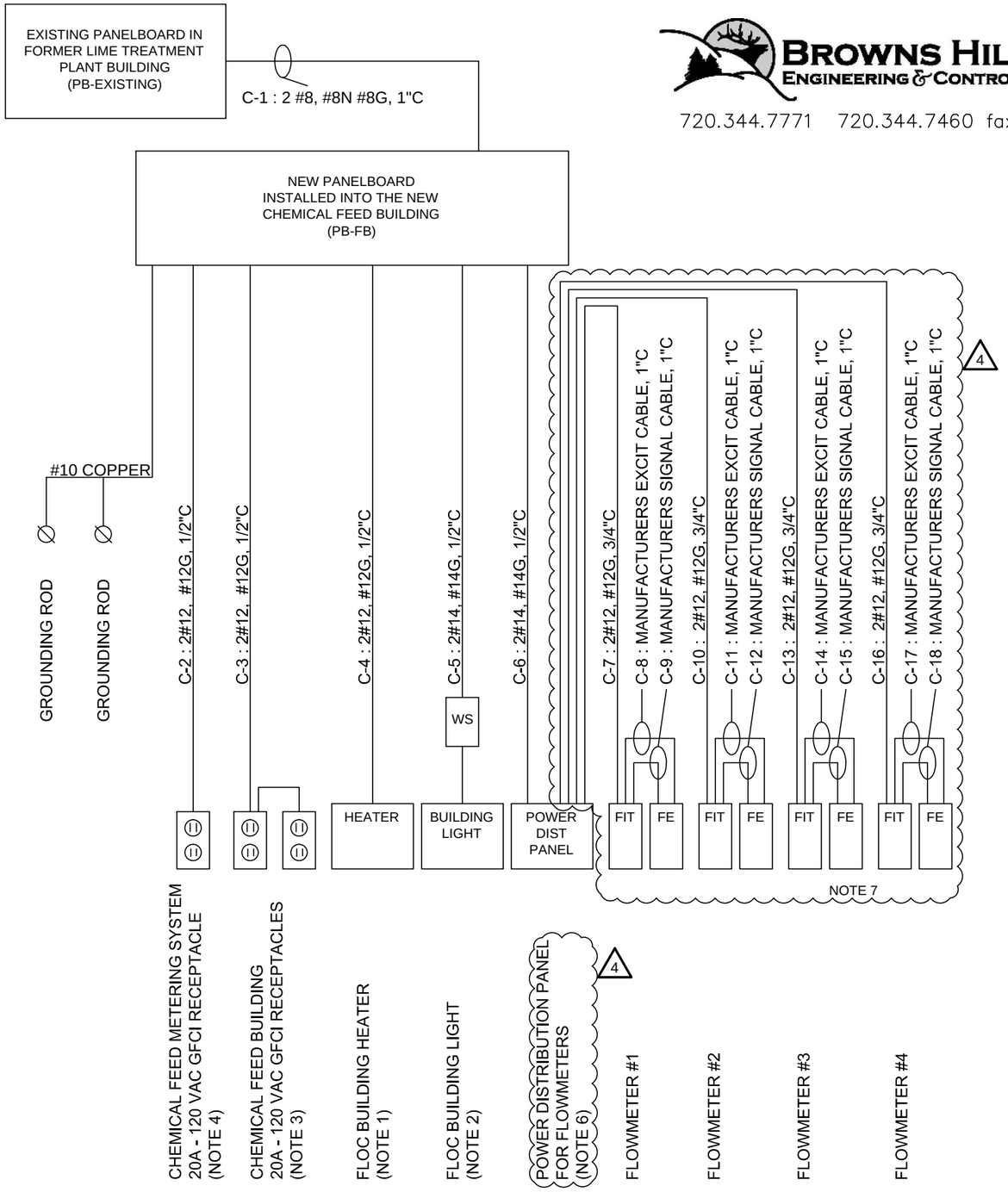
RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

SECTIONS AND DETAILS SHEET
(SHEET 6 OF 6)

DATE: 05/31/13
SCALE: NTS
SHEET: 36 OF 42
PROJ No: SA11161315
36

Plot Date: 09/11/13 - 5:43pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: General Detail Sheet - Revised Floc Bldg.dwg



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EXISTING PANELBOARD IN FORMER LIME TREATMENT PLANT BUILDING

NAME:		PB-EXISTING	BUS:		COPPER				MAIN BREAKER:	
SERVICE		120/240 VAC	RATING:		100A				LOCATION:	OLD LIME BUILDING
MOUNTING		FLUSH, NEMA 1								
V.A.					CIRCUIT NUMBER					V.A.
A	B	LOAD	PHASE	BREAKER			BREAKER	PHASE	LOAD	A	B
1000		LAB LIGHTS	1	20	1	2	20	1	LIGHTING	1000	
	2000	HEATERS	2	20	3	4	20	1	RECEPTACLES		1800
2000		HEATERS	-	-	5	6	30	2	FLOC BUILDING POWER (NOTE 5)	2000	
					7	8	-	-	FLOC BUILDING POWER (NOTE 5)		2000
					9	10					
					11	12					
3000	2000	TOTALS PER PHASE PER SIDE								3000	3800
6000	5800	TOTALS PER PHASE									
	11800	PANEL TOTAL									

NEW PANELBOARD INSTALLED INTO THE NEW CHEMICAL FEED BUILDING

NAME:		PB-FB	BUS:		COPPER				MAIN BREAKER:	2P-30A	
SERVICE		120/240 VAC	RATING:		100A				LOCATION:	FLOC BUILDING	
MOUNTING		SURFACE, NEMA 1									
V.A.					CIRCUIT NUMBER					V.A.	
A	B	LOAD	PHASE	BREAKER			BREAKER	PHASE	LOAD	A	B
1000		CHEMICAL FEED METERING SYSTEM GFCI RECEPTACLE (NOTE 4)	1	20	1	2	20	2	HEATER (NOTE 1)	1500	
	2700	GFCI BUILDING RECEPTACLES (NOTE 3)	1	30 5	3	4	20	2	HEATER (NOTE 1)		1500
200		LIGHTS (NOTE 2) 5	1	15	5	6	20	1	SPARE		
	400	FLOWMETERS POWER PANEL (NOTE 6)	1	15	7	8					
		4			9	10					
					11	12					
1200	3100	TOTALS PER PHASE PER SIDE								1500	1500
2700	4600 5	TOTALS PER PHASE									
	7300	PANEL TOTAL									

NOTES:
1) CHEMICAL FEED BUILDING HEATER TO BE 3000 WATT, 240 VAC, 1PH WITH INTEGRAL THERMOSTAT MOUNTED 1 FOOT FROM THE FLOOR. GRAINGER P/N - 3UG55. IF THE UNIT IS TO BE SURFACE MOUNT RATHER THAN IN-WALL MOUNT, USE MOUNTING FRAME; GRAINGER P/N- 3UF66.
2) CHEMICAL FEED BUILDING INTERIOR LIGHTS ARE TO BE AN INCANDESCENT SURFACE MOUNT LIGHT SOCKETS WITH (2) 100 WATT A19 TYPE LIGHT BULBS. THE LIGHTS ARE TO BE CONTROLLED BY A LIGHT SWITCH MOUNTED AT THE INTERIOR OF THE ENTRY DOOR.
3) THERE ARE TO BE THREE 20 AMP GFCI PROTECTED RECEPTACLES MOUNTED 1 FOOT FROM THE FLOOR AS SHOWN IN DRAWING.
4) THERE IS TO BE A 20 AMP GFCI PROTECTED RECEPTACLE MOUNTED 4.5 FEET FROM THE FLOOR ADJACENT TO THE CHEMICAL FEED METERING SYSTEM.)
5) NEW 2 POLE 30 AMP BREAKER INSTALLED INTO THE EXISTING 240/120 VAC PANELBOARD LOCATED IN THE FORMER LIME TREATMENT BUILDING.
6) 120 VAC POWER DISTRIBUTION PANEL WITH 4 - 2 AMP FUSE BLOCKS FOR CONNECTION TO THE INDIVIDUAL FLOWMETERS.
7) FLOWMETERS ARE TO BE 120 VAC INPUT POWER MODEL.
8) GROUNDING OF THE SYSTEM TO BE PER NEC.
9) CONDUIT IS TO BE BURIED PER NEC AND STANDARD INSTALLATION GUIDELINES.
10) ALL ELECRICAL EQUIPMENT SHALL BE OUTDOOR RATED, GROUND PROTECTED, AND SPLASH PROOF.

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
1	ISSUED FOR REVIEW	05/31/13	STA
2	ISSUED FOR CONSTRUCTION	06/28/13	STA
4	ADDENDUM 2	08/23/13	STA
5	ADDENDUM 3	09/06/13	STA

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RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

ELECTRICAL ONE-LINE DRAWING

DATE: 05/31/13
SCALE: NTS
SHEET: 37 OF 42
PROJ No: SA11161315
37

Plot Date: 09/11/13 - 5:44pm, Plotted by: mark.crater
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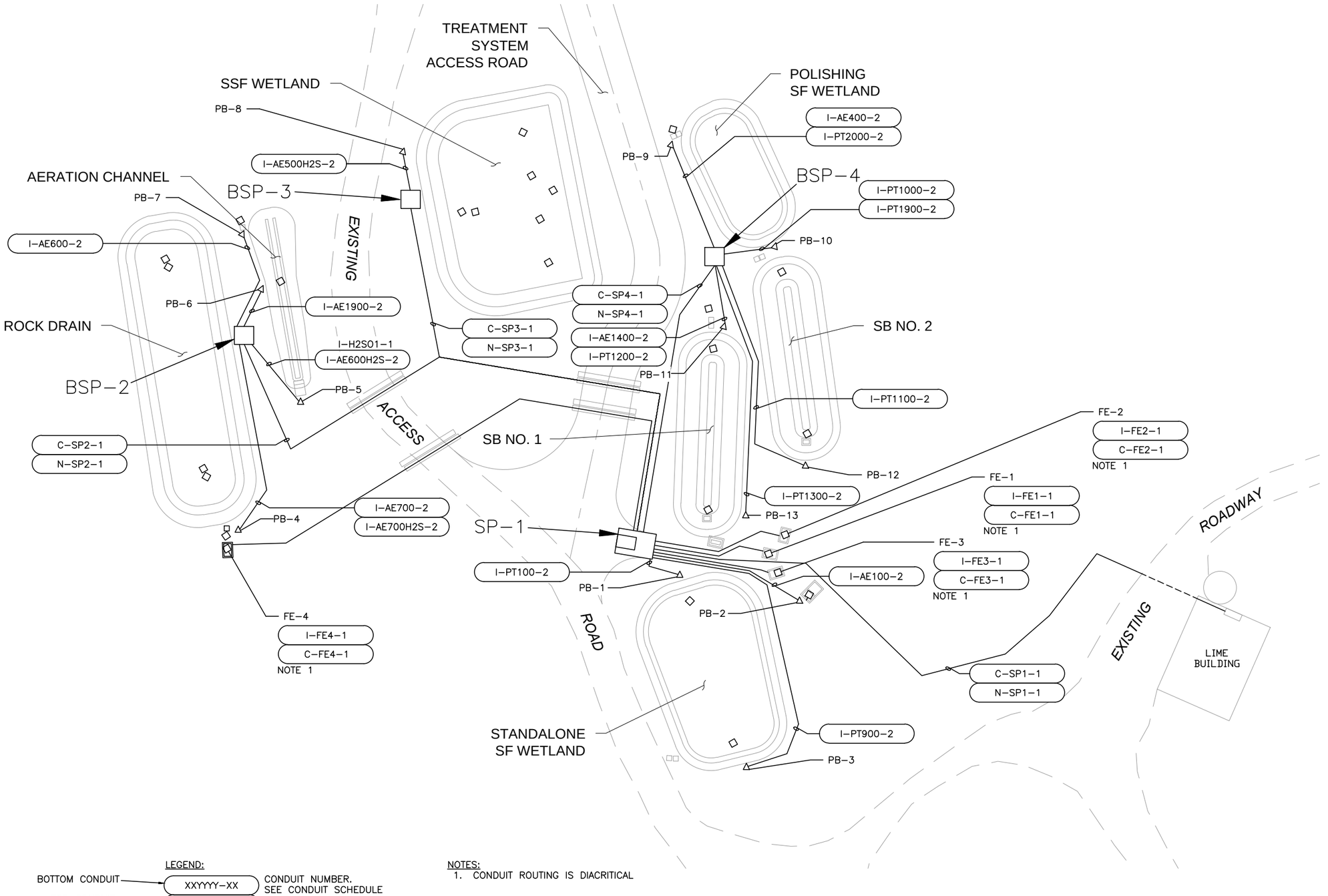

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LEGEND:

BOTTOM CONDUIT — XXYYYY-XX — CONDUIT NUMBER. SEE CONDUIT SCHEDULE FOR CONDUIT SIZE.

TOP CONDUIT — XXYYYY-XX

NOTES:
1. CONDUIT ROUTING IS DIACRITICAL

NORTH

20 0 20 40 FT

REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
4	ADDENDUM 2	08/23/13	CJW

DRAWN CJW
DESIGNED CJW
CHECKED BRW
REVIEWED BRW

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RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

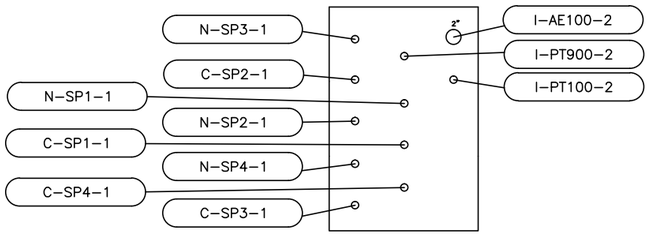
ELECTRICAL CONDUIT RUN

DATE: 08/23/13
SCALE: 1" = 40'
SHEET: 38 OF 42

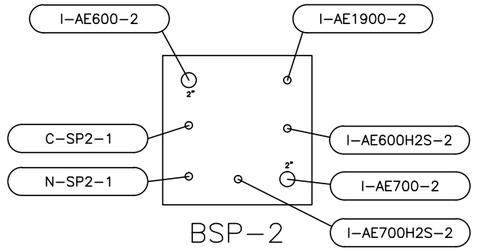
PROJ No: SA11161315

38

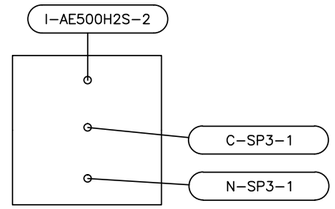
Plot Date: 09/11/13 - 5:44pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: Electrical Conduit Run.dwg



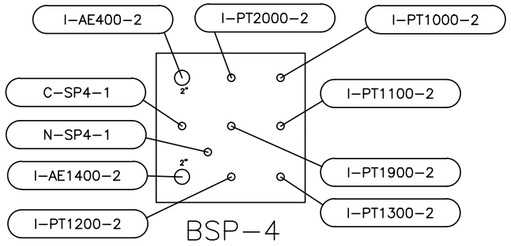
SP–1



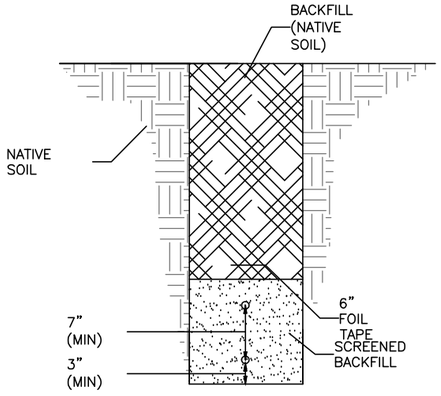
BSP–2



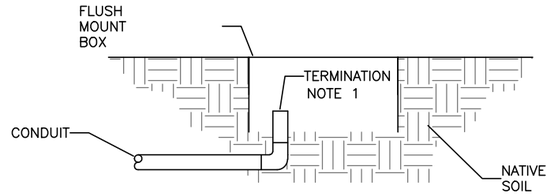
BSP–3



BSP–4



TRENCH DETAIL (TYPICAL):



BOX DETAIL
(TYPICAL):
PB–X

NOTES:

1. A POLYETHYLENE PLUG (OR EQUIVALENT) SHALL BE USED TO TEMPORARILY PLUG CONDUIT ENDS. THIS IS TO KEEP DEBRIS AND FOREIGN MATERIAL OUT OF THE CONDUIT UNTIL USE.

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RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

ELECTRICAL CONDUIT TERMINAL DETAILS

DATE: 08/23/13
SCALE: NTS
SHEET: 39 OF 42
PROJ No: SA11161315
39

Plot Date: 09/11/13 - 5:44pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\ Drawing Name: Electrical Conduit Terminal Details.dwg

REV	CONDUIT NO.	VOLT/AMPS	CONDUIT SIZE (INCH)	CIRCUIT(S) ROUTED IN CONDUIT	FROM	TO	REMARKS	REFERENCES
	C-FE1-1	120VAC	1	FE1-C1	FLOW TRANSMITTER (FT-1)	FLOW ELEMENT (FE-1)	FLOW TRANSMITTER IS LOCATED IN THE CHEMICAL BLDG	38
	I-FE1-1	ANALOG	1	FE1-I1	FLOW TRANSMITTER (FT-1)	FLOW ELEMENT (FE-1)	LOCATED IN CHEMICAL BLDG	38
	C-FE2-1	120VAC	1	FE2-C1	FLOW TRANSMITTER (FT-2)	FLOW ELEMENT (FE-2)	FLOW TRANSMITTER IS LOCATED IN THE CHEMICAL BLDG	38
	I-FE2-1	ANALOG	1	FE2-I1	FLOW TRANSMITTER (FT-2)	FLOW ELEMENT (FE-2)	LOCATED IN CHEMICAL BLDG	38
	C-FE3-1	120VAC	1	FE3-C1	FLOW TRANSMITTER (FT-3)	FLOW ELEMENT (FE-3)	FLOW TRANSMITTER IS LOCATED IN THE CHEMICAL BLDG	38
	I-FE3-1	ANALOG	1	FE3-I1	FLOW TRANSMITTER (FT-3)	FLOW ELEMENT (FE-3)	LOCATED IN CHEMICAL BLDG	38
	C-FE4-1	120VAC	1	FE4-C1	FLOW TRANSMITTER (FT-4)	FLOW ELEMENT (FE-4)	FLOW TRANSMITTER IS LOCATED IN THE CHEMICAL BLDG	38
	I-FE4-1	ANALOG	1	FE4-I1	FLOW TRANSMITTER (FT-4)	FLOW ELEMENT (FE-4)	LOCATED IN CHEMICAL BLDG	38
	C-SP1-1	120VAC	1 1/2	SP1-C1	PANEL BOARD (PB-FB)	CHEMICAL FEED BUILDING PANEL BOARD	PANEL BOARD LOCATED IN LIME PLANT BLDG SCHEDULE 80 PVC IF ABOVE GROUND	38
	C-SP2-1	120VAC	1	SP2-C1	CHEMICAL FEED BUILDING (SP-1)	BOX (BSP-2)		38
	C-SP3-1	120VAC	1	SP3-C1	CHEMICAL FEED BUILDING (SP-1)	BOX (BSP-3)		38
	C-SP4-1	120VAC	1	SP4-C1	CHEMICAL FEED BUILDING (SP-1)	BOX (BSP-4)		38
	N-SP2-1	NETWORK	1	SP2-N1	CHEMICAL FEED BUILDING (SP-1)	BOX (BSP-2)		38
	N-SP3-1	NETWORK	1	SP3-N1	CHEMICAL FEED BUILDING (SP-1)	BOX (BSP-3)		38
	N-SP4-1	NETWORK	1	SP4-N1	CHEMICAL FEED BUILDING (SP-1)	BOX (BSP-4)		38
	N-SP1-1	NETWORK	1	SERV-N1	LIME PLANT BUILDING	CHEMICAL FEED BUILDING (SP-1)	PANEL BOARD LOCATED IN LIME PLANT BLDG SCHEDULE 80 PVC IF ABOVE GROUND	38
	I-PT900-2	ANALOG	1	PT900-I1, PT900TT-I1	CHEMICAL FEED BUILDING (SP-1)	BOX 3 (PB-3)	CONTRACTOR TO FIELD LOCATE PB-3 AS CLOSE TO BERM AS POSSIBLE	38
	I-AE100-2	ANALOG	2	AE100COND-I1, AE100DO-I1 AE100ORP-I1, AE100PH-I1, AE100TT-I1	CHEMICAL FEED BUILDING (SP-1)	BOX 2 (PB-2)	CONTRACTOR TO FIELD LOCATE PB-2 AS CLOSE TO FLOW DIVERSION BOX AS POSSIBLE	38
	I-PT1300-2	ANALOG	1	PT1300-I1, PT1300TT-I1	BOX (BSP-4)	BOX 13 (PB-13)	CONTRACTOR TO FIELD LOCATE PB-13 AS CLOSE TO BERM AS POSSIBLE	38
	I-PT1100-2	ANALOG	1	PT1100-I1, PT1100TT-I1	BOX (BSP-4)	BOX 12 (PB-12)	CONTRACTOR TO FIELD LOCATE PB-12 AS CLOSE TO BERM AS POSSIBLE	38
	I-AE1400-2	ANALOG	2	AE1400COND-I1, AE1400DO-I1, AE1400ORP-I1, AE1400PH-I1, AE1400TT-I1	BOX (BSP-4)	BOX 11 (PB-11)	CONTRACTOR TO FIELD LOCATE PB-11 AS CLOSE TO SB-1 AGRIDRAIN AS POSSIBLE	38
	I-PT1200-2	ANALOG	1	PT1200-I1, PT1200TT-I1	BOX (BSP-4)	BOX 11 (PB-11)	CONTRACTOR TO FIELD LOCATE PB-11 AS CLOSE TO SB-1 AGRIDRAIN AS POSSIBLE	38
	I-PT1000-2	ANALOG	1	PT1000-I1, PT1000TT-I1	BOX (BSP-4)	BOX 10 (PB-10)		38
	I-PT1900-2	ANALOG	1	PT1900-I1, PT1900TT-I1	BOX (BSP-4)	BOX 10 (PB-10)	CONTRACTOR TO FIELD LOCATE PB-10 NEAR EDGE OF BERM AT THE POLISHING SF WETLAND, ALLOWING FOR PROTECTED CIRCUIT AND EASY OF MAINTENANCE.	38

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REFERENCES:
PLANS

DATUM

NO.	REVISION	DATE	APRVD
4	ADDENDUM 2	08/23/13	CJW

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RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

ELECTRICAL CONDUIT SCHEDULE (SHEET 1 OF 2)

DATE: 08/23/13
SCALE: NTS
SHEET: 40 OF 42
PROJ No: SA11161315
40

REV	CONDUIT NO.	VOLT/AMPS	CONDUIT SIZE (INCH)	CIRCUIT(S) ROUTED IN CONDUIT	FROM	TO	REMARKS	REFERENCES
	I-AE400-2	ANALOG	2	AE400COND-I1, AE400DO-I1, AE400ORP-I1, AE400PH-I1, AE400TT-I1	BOX (BSP-4)	BOX 9 (PB-9)	CONTRACTOR TO FIELD LOCATE PB-9 AS CLOSE TO POLISHING SF WETLAND'S AGRIDRAIN AS POSSIBLE	38
	I-PT2000-2	ANALOG	1	PT2000-I1, PT2000TT-I1	BOX (BSP-4)	BOX 9 (PB-9)	CONTRACTOR TO FIELD LOCATE PB-9 AS CLOSE TO POLISHING SF WETLAND'S AGRIDRAIN AS POSSIBLE	38
	I-AE500H2S-2	ANALOG	1	AE500H2S-I1	BOX (BSP-3)	BOX 8 (PB-8)		38
	I-AE600-2	ANALOG	2	AE600COND-I1, AE600DO-I1, AE600ORP-I1, AE600PH-I1, AE600TT-I1	BOX (BSP-2)	BOX 7 (PB-7)	CONTRACTOR TO FIELD LOCATE PB-7 AS CLOSE TO EDGE OF AERATION CHANNEL AS POSSIBLE	38
	I-AE1900-2	ANALOG	1	AE1900DO-I1	BOX (BSP-2)	BOX 6 (PB-6)	CONTRACTOR TO FIELD LOCATE PB-6 AS CLOSE TO EDGE OF AERATION CHANNEL AS POSSIBLE	38
	I-AE600H2S-2	ANALOG	1	AE600H2S-I1, AE600H2S-I2	BOX (BSP-2)	BOX 5 (PB-5)	CONTRACTOR TO FIELD LOCATE PB-6 AS CLOSE TO EDGE OF AERATION CHANNEL AS POSSIBLE	38
	I-AE700-2	ANALOG	2	AE700COND-I1, AE700DO-I1, AE700ORP-I1, AE700PH-I1, AE700TT-I1	BOX (BSP-2)	BOX 4 (PB-4)	CONTRACTOR TO FIELD LOCATE PB-4 AS CLOSE TO THE ROCK DRAIN'S AGRIDRAIN AS POSSIBLE	38
	I-AE700H2S-2	ANALOG	1	AE700H2S-I1	BOX (BSP-2)	BOX 4 (PB-4)	CONTRACTOR TO FIELD LOCATE PB-4 AS CLOSE TO THE ROCK DRAIN'S AGRIDRAIN AS POSSIBLE	38
	I-PT100-2	ANALOG	1	PT100-I1, PT100TT-I1	CHEMICAL FEED BUILDING (SP-1)	BOX 1 (PB-1)	CONTRACTOR TO PLACE PB-1 AS CLOSE TO BERM OF THE STANDALONE SF WETLAND AS POSSIBLE	38

NOTES:

1. ABOVE GROUND CONDUIT TO BE RIGID GALVANIZED STEEL UNLESS OTHERWISE SPECIFIED.
2. UNDERGROUND CONDUIT TO BE SCHEDULE 40 PVC. ALL UNDERGROUND CONDUIT RUNS SHALL BE PROPERLY MARKED WITH BURIED METALIC/FOIL TAPE TO INDICATE AND ALLOW LOCATION OF BURIED RUNS.
3. "STUB-UPS" TO BE PVC COATED/WRAPPED RIGID GALVANIZED STEEL.
4. CONDUIT ROUTING SHOWN ON DRAWINGS ARE SHOWN DIAGRAMMATICALLY. CONTRACTOR IS RESPONSIBLE FOR ULTIMATE ROUTING.
5. CONTRACTOR IS RESPONSIBLE FOR ALL CONDUIT SUPPORTS, PULL BOXES AND MOUNTING.

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CONSTRUCTED WETLAND DEMONSTRATION

ELECTRICAL CONDUIT SCHEDULE (SHEET 2 OF 2)

DATE: 08/23/13
SCALE: NTS
SHEET: 41 OF 42

PROJ No: SA11161315

41

Plot Date: 09/11/13 - 5:44pm, Plotted by: mark.crater
Drawing Path: P:\Project\RICO - SA11161301\2013\CAD\Wetland Demonstration\Plan set\, Drawing Name: Electrical Conduit Schedule.dwg

REV	CIRCUIT NO.	VOLT/AMPS	CONDUCTOR & SIZES	FROM	VIA (ROUTING)	TO	REMARKS	REFERENCES
	FE1 - C1	120VAC	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-1)	C-FE1-1	FLOW ELEMENT (FE-1)	ELEMENT POWER	38
	FE1 - I1	ANALOG	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-1)	I-FE1-1	FLOW ELEMENT (FE-1)	ELEMENT SIGNAL	38
	FE2 - C1	120VAC	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-2)	C-FE2-1	FLOW ELEMENT (FE-2)	ELEMENT POWER	38
	FE2 - I1	ANALOG	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-2)	I-FE2-1	FLOW ELEMENT (FE-2)	ELEMENT SIGNAL	38
	FE 3-C1	120VAC	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-3)	C-FE3-1	FLOW ELEMENT (FE-3)	ELEMENT POWER	38
	FE3 - I1	ANALOG	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-3)	I-FE3-1	FLOW ELEMENT (FE-3)	ELEMENT SIGNAL	38
	FE4 - C1	120VAC	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-4)	C-FE4-1	FLOW ELEMENT (FE-4)	ELEMENT POWER	38
	FE4 - I1	ANALOG	VENDOR CABLE	FLOW TRANSMITTER IN CHEMICAL FEED BUILDING (FT-4)	I-FE4-1	FLOW ELEMENT (FE-4)	ELEMENT SIGNAL	38
	SP1 - C1	REFER TO ELECTRICAL ONE-LINE DRAWING		LIME PLANT PANEL BOARD (PB-FB)	C-SP1-1	CHEMICAL FEED BUILDING (SP-1)		38

NOTES:
1. ALL CONTRACTOR SUPPLIED CABLE AND WIRE TO BE THHW-2 UNLESS OTHERWISE SPECIFIED OR WITH WRITTEN APPROVAL.
2. INSTALLATION OF ELECTRICAL EQUIPMENT INCLUDING CONDUIT, CONDUCTORS AND ALL WIRING SHALL COMPLY TO ALL LOCAL AND NATIONAL CODES AND REGULATIONS. (INCLUDING BUT NOT LIMITED TO NEC, NFPA, OSHA & UL)

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RICO - ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION

ELECTRICAL CIRCUIT SCHEDULE

DATE: 08/23/13
SCALE: NTS
SHEET: 42 OF 42
PROJ No: SA11161315
42

APPENDIX D

Constructed Wetland Demonstration Technical Specifications

RICO-ARGENTINE MINE SITE
CONSTRUCTED WETLAND DEMONSTRATION
TECHNICAL SPECIFICATIONS
ISSUED FOR CONSTRUCTION
June 28, 2013

SECTION 1 - EARTHWORK

1.0 GENERAL

Earthworks to include clearing and grubbing, excavation, removal if unsuitable material, placement and compaction of embankment fill from onsite and borrow sources, preparation for base courses, trenching, bedding, and backfill for pipes and structures, and placement of erosion control material.

1.1 PRODUCTS

1.1.1 Suitable Backfill

Onsite soils suitable for backfill shall contain no peat or humus material, no frozen material, no rocks larger than 1.5-inch diameter, no organic materials, no debris, no calcines, and no sludge. Suitable material shall consist of silty sand and gravel and only small portions of fat clay (CH). Large debris and rocks must be removed from suitable backfill prior to placement.

Imported backfill shall consist of silty sand and gravel with 5 to 35 percent fines (finer than the No. 200 sieve), by weight, and approximately 2 to 20 percent gravel (coarser than the No. 4 sieve), by weight with no material larger than 1.5-inch diameter. The source and material of imported backfill (borrow material) shall be submitted to the Engineer and approved in written prior to purchase, hauling, and placement.

1.1.2 Subgrade (Revised - Addendum 04)

Subgrade material shall contain no peat or humus material, no frozen material, no rounded rocks larger than 6-inch diameter, no angular or sub-angular rocks larger than 3-inch diameter, no organic materials, no debris, ~~no calcines,~~ and no sludge. If it is determined by the Engineer

in the field that calcines left in place as subgrade material is structurally sound (can be compacted to the specified 95% of the Standard Proctor Dry Density) they may be left in place. However, calcines cannot be utilized as fill material. Subgrade shall consist of silty sand and gravel and only small portions of fat clay (CH). Unsuitable material must be removed from the subgrade prior to compaction ~~or~~ and the subgrade shall be replaced with suitable backfill.

1.1.3 Class 6 Aggregate Base Course

Structural backfill shall consist of Class 6 aggregate base course per CDOT specifications.

1.1.4 Erosion Protection

Erosion protection (placed at the pipe outfalls into Pond 18) shall consist of 6"-8" rounded rock.

1.1.5 Bedding Material

Granular sand and gravel bedding material for pipes and structures shall consist of well graded sand and gravel with a maximum size of ¾", and average size of 3/8", and less than 5% passing No. 200 sieve, by weight.

1.1.6 Calcines

Calcines consist of red or purple colored fine grain material as confirmed by Anderson or the Engineer. Calcines are unsuitable for backfill material and must be stockpiled on site in a location coordinated with Anderson.

1.1.7 Sludge

Pond sludge includes fines and organic materials not suitable for backfill. Sludge material must be stockpiles on site in a location coordinated with Anderson.

1.2 EXECUTION

1.2.1 Excavation

The site shall be graded per the Drawings. Drainage features shall be temporarily installed during construction to divert off-site drainage and to prevent ponding of stormwater during construction. Excavation shall be performed in accordance with OSHA standards.

Excavation of suitable material shall be hauled and stockpiled on site. The stockpile location shall be coordinated with Anderson prior to commencement of excavation. No material may leave the site.

1.2.2 Backfill

All backfill (excluding wetland matrix material) shall be placed, graded, and compacted. Final grading shall conform to the Drawings. Backfill shall utilize only material defined as suitable backfill. Backfill material shall be placed in horizontal layers in approximately 6 inch lifts, unless it can be demonstrated that adequate compaction using thicker lifts can be placed while still achieving the compaction goals. Moisture conditioning may be required and water shall be added to condition the material to within 2 percent of the optimum moisture content prior to compaction. Compaction shall be performed to 85% standard proctor.

1.2.3 Subgrade (Revised - Addendum 01)

Below any structural component (concrete structures, road, liner, agridrain, etc.), the subgrade shall be scarified to a depth of 12-inches and recompacted. Material not considered suitable subgrade shall be removed and replaced with suitable backfill. Compaction shall be performed to ~~85~~ 95% standard proctor under concrete structures, agridrains, and the liner. Compaction shall be performed to 95% standard proctor under the access road.

1.2.4 Class 6 Aggregate Base Course

Placement of Class 6 aggregate base course shall be completed in lifts of 6 inches. Moisture conditioning may be required and water shall be added to condition the material to within 2 percent of the optimum moisture content prior to compaction. Compaction shall be performed to 95% standard proctor.

1.2.5 Erosion Protection

Erosion protection rock shall be dumped in place and spread to match the existing slope. No compaction is required other than that necessary to maintain coverage and placement.

1.2.6 Bedding Material

Bedding shall be placed per the Trench Detail in the Drawings. Bedding material around pipe and structures shall be compacted using hand-operated tamping equipment. Bedding shall be placed symmetrically on each side of the structure. Bedding shall be placed for 1 foot above the center of pipe and then backfill shall be performed using suitable backfill material. No heavy earthmoving equipment shall be permitted over the pipe or structure until a minimum of 3 feet of compacted backfill has been placed over the pipe or structure.

1.3 TESTING

1.3.1 Backfill

Compaction and optimum moisture content shall be verified using visual methods, hand field tests, or nuclear density testing.

~~**1.3.2 Subgrade And Class 6 Aggregate Base Course**~~ **(Replaced - Addendum 04)**

~~Compaction of the Subgrade and Class 6 Aggregate Base Course on the Treatment System Access Road will be verified using a proof roll method. Proof rolling shall be performed immediately after compaction of the subgrade and prior to placement of the Class 6. Upon approval of the subgrade proof rolling, the Class 6 aggregate base course shall be placed within 48 hours. If the Contractor fails to place the Class 6 aggregate base course within 48 hours or the condition of the subgrade changes due to weather or other conditions, proof rolling and correction shall be performed again at the Contractor's expense. The Class 6 proof rolling shall be performed immediately after compaction of the Class 6 efforts to ensure that the soil is at its optimum moisture content, or at the moisture content specified for compaction.~~

~~Proof rolling shall be performed by driving a 2,000-gallon water truck along the compacted base course at speeds between 3 and 5 mph. The proof roll shall be observed by the Engineer and the Contractor.~~

~~Areas that are observed to have soft spots, where deflection is not uniform or is excessive as determined by the Engineer, shall be ripped, scarified, dried or wetted as necessary and recompacted to the requirements for density and moisture at the Contractor's expense. After recompaction, these areas shall be proof rolled again and all failures again corrected.~~

1.3.2 Subgrade And Class 6 Aggregate Base Course

Compaction of the Subgrade and Class 6 Aggregate Base Course on the Treatment System Access Road shall be verified using a nuclear densometer. Areas that are do not meet 95% compaction shall be recompacted and/or ripped scarified, dried or wetted as necessary until the area meets the specifications.

SECTION 2 - PIPE, FITTINGS, VALVES, APPERTUANCES, HYDRAULICS CONTROL STRUCTURES

2.0 GENERAL

Piping shall be installed per the location and elevations as specified in the Drawings. Valve, flow meters, mixers, etc. shall also be installed as conveyed in the Drawings. Hydraulic control structures such as inlet boxes, outlet boxes, agridrains, and perforated pipe shall be installed per the Drawings. This section shall also pertains to storm drain pipe, manholes, and inlets.

2.1 PRODUCTS

2.1.1 Piping

All 3 and 4 inch diameter pipe shall be Schedule 80 Polyvinyl Chloride (PVC). All perforated pipe shall be Schedule 40 PVC. All storm drain pipe and culverts shall be corrugated high density polyethylene (CHDPE) double wall with corrugated exterior and smooth interior wall.

2.1.2 Concrete Structures, Storm Manholes And Inlets, And Agridrains

Concrete structures shall be supplied per the Materials List. Any substitutions must be approved by the Engineer, in written, prior to purchase.

2.1.3 Valves, Meters, Static Mixer (Revised - Addendum 01)

~~Concrete structures~~ Valves, meters, and static mixer shall be supplied per the Materials List. Any substitutions must be approved by the Engineer, in written, prior to purchase.

2.2 EXECUTION

2.2.1 Piping

Pipe trenching shall be executed per the specifications in the Earthworks section. Pipe placement shall be performed per the manufacturer's recommendation. Pipe invert elevations must be within +/- 0.05 feet of the design elevation in the Drawings. Pipe slopes may vary but must be 1.0% minimum. The pipe elevations and slopes must be verified by survey pipe prior to bedding beyond the centerline of the pipe. Pipe joints and fittings shall match the schedule rating of the pipe. PVC pipe and fittings shall be solvent-cemented in accordance with ASTM A798. Pipe installation must be tested prior to backfill.

Pipe with less than 6-ft cover (excluding the storm drain and culverts) must have insulation per the Trench Detail in the Drawings. Insulation shall be placed as the trench is backfilled.

2.2.2 Concrete Structures, Storm Manholes And Inlets, And Agridrains

Concrete structures shall be placed on compacted subgrade followed by 6 inches of Class 6 material compacted per the specifications in the Earthworks section. Structure invert and rim elevations (where applicable) shall be within +/- 0.05 feet of the design elevation in the Drawings.

2.2.3 Valves, Meters, Static Mixer

All valves, meters, and static mixer shall be installed per the Drawings and in accordance with the manufacturers' recommendations. Support all valves, meters, and mixer as necessary. Provide all fittings and accessories for proper installation and operation.

2.3 TESTING

2.3.1 Piping

Perforated pipe, storm drain pipe, and culverts do not require leak testing.

All 3 inch piping shall be leak tested using a low pressure air test with pneumatic plugs at either end of the pipe segment. One of the plugs provided shall have two taps. One tap will be used for introducing air into the pipeline through suitable valves and fittings so that the input air may be regulated. The second tap shall be fitted with valves and fittings to accept a pressure gauge to monitor the internal pressure of the pipe. The pressure gauge shall be 4.5" diameter, with bourdon tube or diaphragm, 0-15 psi pressure range with 1 psi figure interval and 0.05 psi minor increments.

The procedure shall be as follows: Connect the pressure gauge and air control equipment to the proper fittings and slowly apply air pressure. Pressurize the pipe line to 4.0 psig and throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs for leakage. If plugs are found to leak, bleed off air, tighten plugs, and repressurize the pipeline. After the temperature has stabilized, allow the pressure to decrease to 3.5 psig. At 3.5 psig begin timing to determine the time required for pressure to drop to 2.5 psig. The time, in seconds, for the air pressure to drop from 3.5 psig to 2.5 psig should be greater than 18 seconds per 100 feet of pipe tested. If the air test fails to meet this time requirement, the leak shall be located and repaired at the Contractor's expense and the pipeline shall be retested until the leakage is within the allowable limits.

2.3.2 Concrete Structures And Agridrains

All concrete structures (excluding storm drain manholes and inlets) and agridrains shall be leak tested by performing a hydrostatic leak test. The inlet and outlet of the structure shall be sealed

with watertight plugs or bulkheads and the structure shall be filled with water to within 6-inches of the top/rim. The test level shall be clearly marked in the structure. Concrete structures shall be filled and maintained full of water for a period of at least 24 hours prior to the start of the test in order to saturate the concrete. If the water level in the concrete structure drops during this 24 hour period, the level shall be raised to the test level mark prior to start of the test. All vent holes in the lid shall be plugged and the lid shall be installed prior to start of the test.

The test shall last a minimum of 24 hours. Once the test begins, the structure's lid shall only be removed in the presence of the Engineer. Exfiltration will be determined by measuring the amount of water required to raise the water level back to the marked level at the end of the test period. The structure shall be considered to pass the water exfiltration test if the exfiltration volume is less than 0.3 gallons per 100 gallons of volume in the structure during the test or if the water level decreased less than 1/8 inch over the test period. If the structure fails the water exfiltration test, the structure shall be repaired with a non-shrinkable grout or other material approved by the Engineer, or completely replaced. The water exfiltration test shall then be repeated until a satisfactory test is obtained. All temporary plugs shall be removed after each test.

SECTION 3 - GEOGRID, GEOTEXTILE, AND GEOMEMBRANE LINER

3.0 GENERAL

The basins shall be lined with 2 layers of geotextile and 1 layer of geomembrane per the Drawings. Geogrid may also be required beneath the geotextile and liner if the subgrade is too soft for the Contractor to install the liner.

3.1 PRODUCTS

~~3.1.1 Geogrid~~ (Replaced - Addendum 02)

~~Geogrid includes mechanically stabilized subgrade of base/subbase course and/or subgrade improvement. Not only does this system allow access and construction for less than ideal situations, it also offers a predictable engineering solution. This solution relies on geogrids and aggregate base acting together to create a stronger composite structure, which increases the performance of the underlying subgrade or aggregate base course.~~

~~The purpose of the work shall be to provide a stabilized working platform section on which wetland geotextile, liner and matrix materials can be placed. This Item shall not be used to retain moisture in subgrades unless retaining moisture in the section can be assured. This specification shall be used for a construction platform and not as a means of mitigating swell.~~

~~The preferred gradation for base reinforcement application is well-graded crushed aggregate fill with a maximum particle size (100 percent passing) of 1 ½ inches, and less than 10% fines (passing the #200 sieve). Recycled concrete may be used only with polypropylene geogrids in accordance with FHWA 2001. Reasonably well-graded 1½-inch minus granular fill may be accepted by the Engineer for this unpaved application of wetland construction.~~

~~Structural Soil Reinforcement Geogrid – The geogrid shall be integrally formed and deployed as a single layer having the following characteristics according to Table 3.1.1 (ALL VALUES ARE MINUMUM AVERAGE ROLL VALUES UNLESS A RANGE OR CHARACTERISTIC IS INDICATED):~~

Table 3.1.1 TX 160 GEOGRID OR EQUIVALENT PROPERTY VALUES

Geogrid Properties	Test Method				
		Longitudinal	Diagonal	Transverse	General
Type of Geogrid					Punched and Drawn
Rib pitch	Nominal Dimensions	1.6 in	1.6 in		
Mid-Rib Depth	Nominal Dimensions	0.07 in	0.06 in		
Mid-Rib Width	Nominal Dimensions	0.04 in	0.05 in		
Rib Shape	Observation				Rectangular
Aperture shape	Observation				Triangular(4)
Junction Efficiency(1)	GRI-GG2-87				93 %
Radial Stiffness(2)	ASTM 6637-01				20,580 lb/ft @ 0.5% strain
Resistance to Long Term Degradation(3)	EPA 9090 Immersion Testing				100%

1. Load transfer capability determined in accordance with GRI-GG2-87 and expressed as a percentage of ultimate tensile strength.
2. Determined from tensile stiffness measured in any in-plane axis from testing in accordance with ASTM D6637-01.
3. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090.
4. Geogrid is manufactured from a punched polypropylene sheet, which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the original node.

Geotextile materials shall not be considered as an alternate to geogrid materials for subgrade improvement or base/sub-base reinforcement applications. A geotextile may be used in the cross-section to provide separation, filtration or drainage; however, no structural contribution shall be attributed to the geotextile.

Prior to material purchase, the Contractor shall submit the geogrid product data sheet, certification, and/or independent full scale laboratory testing from the manufacturer that the geogrid product supplied meets the requirements listed above. Three days prior to installation, the Contractor shall submit manufacturer's installation instructions and general recommendations.

3.1.1 REINFORCEMENT GRADE WOVEN GEOTEXTILE

3.1.1.1 Delivery, Storage, and Handling

Geotextile labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. Each geotextile roll shall

be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextile.

3.1.1.2 Products

The purpose of the work shall be to provide a stabilized working platform section on which wetland geotextile fabrics, liner, and matrix materials can be placed over otherwise unstable (i.e. soft) materials. This specification shall be used for a construction platform and not as a means of mitigating swell. Reinforcement grade geotextile shall be woven from high-tenacity long-chain synthetic polymers composed of at least 95 percent by weight polyolefins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

The geotextile shall meet the requirements of Table 3.1.1. All numeric values in the table except Apparent Opening Size (AOS) represent minimum average roll values (MARV) in the specified directions. Values for AOS represent maximum average roll values.

Table 3.1.1. Subgrade Stabilization Geotextile

Property	Test Method	Units	Required Value	
Reinforcement Properties			**MD**	**CD**
Tensile Strength @ Ultimate	ASTM D4595	lbs/ft (kN/m)	4800 (70)	4800 (70)
Tensile Strength @ 2% Strain	ASTM D4595	lbs/ft (kN/m)	960 (14)	1320 (19.3)
Tensile Strength @ 5% Strain	ASTM D4595	lbs/ft (kN/m)	2400 (35)	2700 (39.4)
Coefficient of Interaction – Ci (sand)	ASTM D5321	-	0.8	
Permittivity	ASTM D4491	Sec^{-1}	0.4	
Apparent Opening Size	ASTM D4751	U.S. Sieve (mm)	30 (0.6)	
Sewn Seam Strength[(1)]	ASTM D4884	lbs/ft (kN/m)	3000 (43.8)	
Survivability Index Values			**MD**	**CD**
Grab Tensile Strength	ASTM D4632	lbs (N)	475 (2114)	440 (1958)
Tear Strength	ASTM D4533	lbs (N)	180 (801)	180 (801)
CBR Puncture Strength	ASTM D6241	lbs (N)	2000 (8900)	
Ultraviolet Stability (after 500 hrs)	ASTM D4355	%	80	
1. When sewn seams are required. Refer to the Execution for overlap/seam requirements.				

3.1.1.3 Approved Geotextile

Mirafi HP 570 or the equivalent.

3.1.2 Geotextile

The materials supplied as non-woven geotextile shall be of new first-quality (needle-punched; heat-; or spun-bound; or stapled) polymer of 100 percent polyethylene or polypropylene (97 percent polypropylene and 3 percent carbon black with antioxidants and heat stabilizers), or polyester/polypropylene blend designed and manufactured specifically for the purpose of separation, tensile reinforcement, planar flow, and filtration and shall be used as designated on the Drawings. The non-woven shall have a mass per unit area of 12 oz/yd2 unless designated otherwise on the Drawings.

The materials shall be produced to be free of holes, undispersed raw materials, broken needles, or any sign of contamination by foreign matter. The geotextile fabric shall be uniform in color; thickness; size; and texture; and all rolls shall be properly tagged and identified by the manufacturer with the manufacturer's name, product identification, roll number, roll identification, and other pertinent information to fully describe the geotextile.

The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of this specification. Documentation describing the quality control program shall be made available upon request. Testing shall be performed in accordance with the methods referenced in this specification. The manufacturer's certificate shall state that the finished geotextile meets the requirements of the specification. Either mislabeling or misrepresentation of materials shall be reason to reject those geotextile products.

The material supplied as non-woven geotextile shall conform to the standards outlined in the following table:

Properties	ASTM Test Method	Value [a]				Minimum Test Frequency (1 per)
Mass per unit area, oz/yd²	D5261	6	8	10	12	90,000 ft²
Grab tensile strength, lbs	D4632	170	220	260	320	90,000 ft²
Grab elongation, %	D4632	50	50	50	50	90,000 ft²
Puncture strength, lbs	D4833	110	135	180	210	90,000 ft²
Mullen burst strength, psi	D3786	330	420	520	620	90,000 ft²
Trapezoidal tear strength, lbs	D4533	70	95	100	125	90,000 ft²
Apparent opening size, sieve #	D4751	70	80	100	100	540,000 ft²
Permeability, cm/s	D4491	0.30	0.30	0.30	0.29	540,000 ft²
Water flow rate, gpm/ft²	D4491	110	110	85	60	540,000 ft²
UV resistance (%) [b]	D4355	70	70	70	70	per formulation

[a]All values are Minimum Average Roll Values (MARV) except UV resistance and apparent opening size in mm. Apparent opening size is a Maximum Average Roll Value. UV is a typical value.

[b]Evaluation to be 2-inch strip tensile specimens after 500 hours of exposure.

[c]Values that represent directional properties are specified for the weaker principal direction.

Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate. Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight, and contaminates. The protective wrapping shall be maintained during periods of shipment and storage. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, and any other environmental conditions that may damage the property values of the geotextile.

3.1.3 Geomembrane Liner

The geomembrane shall be double sided textured High-Density Polyethylene (HDPE) 60-mil nominal thickness unless otherwise designated on the Drawings.

The HDPE geomembrane shall be a high quality formulation containing approximately 97 percent polymer and 3 percent carbon black with antioxidants and heat stabilizers. It shall be resistant to ultraviolet (UV) rays. All resin shall be hexene-based, consist of all virgin material from the same manufacturer, shall not be intermixed, and no reclaimed polymer may be added to the resin. The manufacturing process shall not use more than 10 percent re-work. If re-work is used, it must be similar HDPE to the parent material.

The geomembrane material shall comprise HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures as applied to the mining industry. The material shall be produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. The geomembrane is to be supplied in roll form. Each roll is to be identified with labels indicating roll number, thickness, length, width, and manufacturer's name.

The geomembrane manufacturer shall be ISO 9000/2000 certified. The manufacturer's laboratory must be certified by Geosynthetic Accreditation Institute (GAI)/Laboratory Accreditation Program (LAP) for the tests being performed and shall have a third-party independent quality assurance program. The third party shall perform the required tests at the required frequency as stated in this specification or at such frequency as is mutually agreed by the Owner, the Engineer, and the manufacturer at the time of award. All test results shall be provided to the Owner, and the rolls of material shall be clearly identified and correlate to the test results.

Extrudate rod or bead material shall be made from the same type of resin as the geomembrane and be from the same resin supplier as the resin used for manufacture of the geomembrane.

The material shall be warranted against manufacturer's defects as well as degradation due to UV light for exposed areas for a minimum of 20 years from the date of installation or as mutually agreed prior to award of the contract for supply between the Owner and the geomembrane manufacturer. This warranty shall cover the cost of material, freight and duties, handling, labor, and equipment to replace the defective or failed material.

The material supplied shall conform to the standards outlines in the Tables at the end of this section. The manufacturer shall furnish the following product data, in writing, to the owner prior to shipment of the geomembrane material:

1. Resin data including the following:
    a. Certification stating that the resin meets the specification requirements and that it is all from the same manufacturer
    b. Statement certifying no reclaimed polymer is added to the resin
    c. Copy of quality assurance/quality control certificates issued by resin supplier
2. Geomembrane roll/extrudate rod and bead material:

a. Copy of quality assurance/quality control certificates issued by the geomembrane manufacturer and the third-party independent quality assurance tester

b. Certification that the geomembrane material delivered to the project complies with these specifications

c. Certification that extrudate rod or bead is from one manufacturer, is the same resin type, and was obtained from the same resin supplier as the resin used to manufacture the geomembrane rolls.

Conformance tests shall be conducted using the following ASTM testing methods (at a minimum) of one sample per resin lot:

60-mil HDPE Textured Geomembrane
•ASTM D5994 – Thickness
•ASTM D1505 – Density
•ASTM D6693 – Tensile Properties
•ASTM D4833 – Puncture Resistance
•ASTM D1603 – Carbon Content

3.2 EXECUTION

~~3.2.1 Geogrid~~ (Replaced - Addendum 02)

~~The Contractor shall check the geogrid upon delivery to verify that the proper material has been received. The geogrid shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.~~

~~Storage of the geogrid:~~

~~1. Prevent excessive mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to the geogrid materials.~~

~~2. Store at temperatures above -20 degrees F (-29 degrees C).~~

~~3. Rolled materials may be laid flat or stood on end.~~

~~4. Geogrid materials should not be left directly exposed to sunlight for a period longer than the period recommended by the manufacturer (as per ASTM D4355).~~

~~The subgrade soil elevation shall be prepared at the proper elevation and alignment as directed by the Engineer or as indicated on the Drawings. The geogrid shall be installed in accordance with the installation guidelines provided by the manufacturer or as directed by the Engineer. Provide 24-inch minimum overlap at edges and ends of rolls. The geogrid may be temporarily~~

~~secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions.~~

~~Vehicle Operation Over Geogrids – A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph) when integrally-formed geogrids are used. This shall not be allowed with coated geogrids and sharp turning movements shall be avoided.~~

~~No Operation Over Geogrids – Granular fill of a minimum loose fill thickness of 6 inches may not be required if operation of tracked vehicles is not allowed over the geogrids.~~

~~Compaction – Standard compaction methods may be used unless the soils are very soft. In these cases, static instead of vibratory compaction is prudent, particularly over silty subgrades. Compaction is then achieved using a light roller. Keeping fill moisture content near optimum will make compaction more efficient. Water spray is most effective with sand fill. Compact aggregate fill to project specifications, after it has been graded smooth and before it is subject to accumulated traffic.~~

3.2.1 REINFORCEMENT GRADE GEOTEXTILE INSTALLATION

The Contractor shall check the reinforcement grade woven geotextile upon delivery to verify that the proper material has been received. The geotextile shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

Install reinforcement grade woven geotextile at locations shown on the Drawings or as designated by the Engineer. Two layers of reinforcement grade woven geotextile shall be placed on the excavated subgrade. The two layers shall be oriented to ensure that their principal strength directions are perpendicular to each other.

Sewn and overlapped joints shall meet manufacturer's recommendations for reinforcement over subgrade. Where subgrade is firm, sewing or 36-inch overlap shall be used for joint connections and tear repair. In wet areas where subgrade is extremely soft, roll joints or repair joints shall be sewn to meet the sewn strength shown in Table 3.1.1.

On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

Prior to covering, the geotextile shall be inspected by the Engineer to ensure that the geotextile has not been damaged during installation. Damaged geotextile shall be repaired immediately. Install a patch over a damaged area and extend 3 feet beyond the perimeter of the tear or damage and sew or overlap patch.

A minimum 24-inch thick 1.5-inch minus sub-round to sub-angular fill shall be placed atop the two layers of geotextile. Sharp rock and objects shall be avoided. At soft or critical locations, another layer of geotextile may be placed in the middle of the 24-inch thick fill as directed by the Engineer. The bottom 12-inches of fill shall be placed in a single 12-inch lift and compacted to a density equivalent to 95% of the standard proctor. In extremely soft conditions, the lower 12-inch lift may be placed uncompacted. The top 12-inches of fill shall be placed in two 6-inch lifts and compacted to a density equivalent to 95% of the standard proctor.

The fill shall be placed by end dumping onto the geotextile from the edge of the geotextile or over previously placed fill. Sudden braking and sharp turning shall be avoided. Tracked construction equipment should not be operated directly upon the geotextile. A minimum fill thickness of 12 inches is required prior to operation of tracked vehicles over the geotextile. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geotextile. Turning of vehicles shall not be permitted on the first lift above the geotextile.

If placement of the backfill material causes damage to the geotextile, the damaged area shall be repaired as previously described above. The placement procedure shall then be modified to eliminate further damage from taking place.

3.2.2 Geotextile

The non-woven geotextile shall be installed on the areas shown on the Drawings or as directed by the Engineer.

The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Should the Contractor damage the geotextile to the extent that it is no longer usable as determined by these Specification or by the Engineer, the Contractor shall replace the geotextile at their expense.

All geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

Necessary precautions shall be taken to prevent damage to adjacent or underlying materials during placement of the geotextile. Should damage of such material occur due to the fault of the Contractor, the latter shall repair the damaged materials at their own cost and to the satisfaction of the Engineer.

The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sunlight for more than 15 days after installation.

When seaming is specified, the geotextile shall be seamed using heat seaming or stitching methods as recommended by the Geotextile Manufacturer and approved by the Engineer. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat seaming, fusion-welding techniques recommended by the Geotextile Manufacturer shall be used.

All joints shall have a minimum 6-inch overlap and shall be continuously heat-fused or alternatively can be sewn where it is used to enclose drainage material around a pipe or other structure.

Equipment shall not be allowed to traffic directly on the geotextile.

Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

Holes in the geotextile material shall be repaired using a patch of identical material extending a minimum 6 inches on all sides of the hole and heat bonded. If heat bonding is not possible, the patch shall extend a minimum of 18 inches on all sides of the hole.

In areas where the non-woven geotextile is used as separation or filtration, care will be taken to install the layer without producing holes or gaps where the migration of fines into the drainage system could occur. This is done by ensuring sufficient overlap of seams of 18 inches minimum overlap and properly wrapping the edges of the geotextile under the gravel areas being protected or by over running the edges of the geotextile passed the area requiring separation or filtration.

3.2.3 Geomembrane Liner

The HDPE geomembrane shall be installed on the areas shown on the Drawings or as directed by the Engineer or Engineer.

Prior to deployment of geomembrane, the Installer shall inspect and accept, with the Engineer and the Owner, all surfaces on which the geomembrane is to be placed. The surface on which the geomembrane is to be installed shall be free of sharp particles, rocks, or other debris to the satisfaction of the Engineer, the Owner, and the Installer. Sharp objects shall be removed by raking, sweeping, or handpicking as necessary.

The Installer shall supply the Engineer with panel layouts of the liner that must be approved by the Engineer prior to commencing the Work. It is the Installer's responsibility to submit timely proposals (allowing a minimum of two weeks for approval).

Installation of the geomembrane shall be performed under the direction of a field engineer or supervisor who has installed a minimum of 10,000,000 square feet of flexible geomembrane material. The geomembrane shall be placed over the prepared surfaces using methods and procedures that ensure a minimum of handling. Adequate temporary and permanent anchoring devices and ballasting shall be provided to prevent uplift and damage due to winds. The Installer is solely responsible for the safety of his operations including decisions regarding deployment in adverse weather conditions and the amount of temporary anchoring and ballasting required.

To the extent possible, seams shall be oriented parallel to the slope of the ground. The panels shall be secured temporarily with sandbags or other approved ballasting method to hold them in place until the field seams have been completed and the geomembrane has been permanently anchored.

The Installer shall take into account that frequent high winds may result in delays. The Installer shall take all necessary measures to ensure that each panel is sufficiently ballasted to prevent damage or movement by wind. Fusion of panels and repairs will only be permitted under weather conditions allowing such work, and within the warranty limits of the Geomembrane Manufacturer, as approved by the Owner and the Engineer.

Horizontal field seams on slopes shall be kept to a minimum. Horizontal seams on steep slopes shall be avoided where possible by cutting the liner at a 45-degree angle. Generally, horizontal seams are to be no closer than 10 feet from the toe of the slope. Horizontal seams shall be made by lapping the uphill material over the downhill material. Panels shall be shingled in a manner that prevents water from running beneath the liner.

The geomembrane shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. The installed geomembrane shall contain sufficient slack

material to allow for thermal expansion and contraction. Individual wrinkles should take the form of undulations in the liner but should not be large enough for the material to fold over itself.

During installation, the Installer shall give each field panel an "identification" code number consistent with the layout plan. The Engineer shall agree upon the numbering system. The Installer shall update the layout plan as each panel is installed to show the location of each panel. A field panel is defined as the area of geomembrane that is to be seamed in the field (roll or portion of a roll cut in the field).

Individual panels of geomembrane material shall be laid out in a pattern that will produce the least number of seams. The material shall be overlapped prior to welding. Extreme care shall be taken by the Installer in the preparation of the areas to be welded. The joint interface shall be cleaned and prepared according to procedures laid down by the material manufacturer and approved by the Engineer. Seaming shall not take place unless the panel is dry and clean. All sheeting shall be welded together by thermal methods.

Any area showing damage due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The cost of replacing or repairing the geomembrane shall be borne solely by the Installer.

No "fish mouths" will be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap extrusion weld applied.

Geomembrane panels must have a finished overlap of 4 to 6 inches for double-wedge welding seams and minimum 6 inches for extrusion welding seams. Notwithstanding this provision, sufficient overlap shall be provided to allow peel tests to be performed on any seam.

Handling and storage of the geomembrane material shall be in accordance with the manufacturer's printed instructions. Persons walking or working on the geomembrane shall not engage in activities or wear shoes that could damage the geomembrane.

An adequate number of handling equipment, welding apparatuses, and test equipment shall be maintained on site to avoid delays due to problems with equipment failures.

3.3 TESTING

3.3.1 Geotextile

The Engineer may randomly inspect geogrid before, during and after (using test pits) installation.

Any damaged or defective geogrid (i.e. frayed coating, separated junctions, separated layers, tears, etc.) will be repaired/replaced. Any roll of geogrid damaged before, during and after installation shall be replaced by the Contractor at no additional cost to the Owner. Proper replacement shall consist of replacing the affected area adding 3ft (1m) of geogrid to either side of the affected area.

3.3.2 Geomembrane Liner

3.3.2.1 General

The Installer shall submit a copy of his Quality Control Manual to the Engineer through the Owner prior to the start of installation of any geomembrane. If there are discrepancies between this specification and the Installer's Quality Control Manual, the more stringent requirements will apply unless determined otherwise by the Engineer.

The Installer shall be fully responsible for carrying out all quality control tests on the geomembrane and shall do so to the satisfaction of the Engineer and in accordance with this Specification and the Installer's Quality Control Manual. On-site physical nondestructive and destructive testing shall be completed on all joints to ensure that watertight uniform seams are achieved on a continuous basis as installation proceeds. At the time of bid submission, details shall be provided by the Installer that set forth the method proposed for both destructive and nondestructive testing of seams. The Engineer shall approve these methods prior to the Installer commending the Work. Visual inspection alone is unacceptable.

Fusion of panels and repairs will only be permitted under weather conditions allowing work that is in conformance to the Specifications and within the warranty limits imposed by the manufacturer and to the approval of the Engineer.

At a minimum, the Installer's field installation test program shall consist of periodic visual observations and continuity and strength tests as defined in the following subsections.

3.3.2.2 Trial Welds

Trial welds shall be completed to verify the performance of the welding equipment and operator prior to performing production welds. No welding equipment or operator shall perform production welds until equipment and operator have successfully completed a trial weld. The following procedures shall be followed for trial welds:

- Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

- Minimum of two trial welds per day per welding apparatus – one made prior to the start of work and one completed at mid-shift or for every 5 hours of seaming operations.

- Cut five 1-inch-wide-by-6-inch-long test strips from the trial weld.

- Quantitatively test specimens for peel adhesion and then for bonded seam strength (shear).

- Trial weld specimens shall pass when the results shown in Table 4 are achieved in both peel and shear tests and:

- The break, when peel testing, occurs by Separation In the Plane of the sheet (SIP), not through adhesion failure separation (AD).

- The break is ductile.

- Repeat the trial weld, in its entirety, when the trial weld samples fail in either peel or shear as defined on Table 4, footnote 2.

3.3.2.3 Field Seaming

The Contractor shall have at least one master welder who will provide direct supervision over other welders as necessary.

- The welding equipment shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the material to ensure changes in environmental conditions will not affect the integrity of the weld.

- The seam area shall be cleaned of dust, mud, moisture, and debris immediately ahead of the welding apparatus.

- The seam overlaps shall be aligned consistent with the requirements of the welding equipment being used. A 4- to 6-inch overlap shall be used for double wedge welded seams and 6-inches for extrusion welded seams unless approved otherwise by the Engineer.

- Seaming shall not proceed when the ambient air temperature or adverse weather conditions jeopardize the integrity of the geomembrane installation.

- Extrusion welding apparatus shall be purged of heat-degraded extrudate before welding.

- The double-wedge fusion welding process shall be used unless alternate methods are approved by the Engineer. Extrusion welding will be permitted to weld short seams, to repair small areas, where double-wedge welding is not feasible, and where test samples have been removed.

The Installer shall perform visual inspections of deployed and welded HDPE panels to identify defects, damage, or protrusion of sharp objects that may affect the integrity of the geomembrane. Defective or damaged areas will be marked and repaired according to the Technical Specifications and the guidelines in the Installer's Quality Control Manual.

A quality control technician or field engineer acting for the Installer shall inspect each seam, marking his initials and date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

3.3.2.4 Continuity Testing

A maximum effort shall be made to install a perfect geomembrane liner. This implies that all seams completed in the field, patches, and extrusions shall be tested and recorded. All failures shall be isolated and repaired as directed by the Engineer. A general testing procedure is included as follows:

- Test all field seams and patches with interseam pressure, vacuum box, spark tester, or other approved methods. Pressure and vacuum testing are discussed in following subsections.
- Isolate and repair all areas indicating any leakage. Retest the repair.

Interseam Pressure Testing: Test procedure for interseam pressure for seams (for double-wedge welding only):

- Seal both ends of the seam to be tested by applying heat to the end of the seam via a heat gun until flow temperature is achieved. Clamp off the ends and let cool.
- Insert a pressure gauge/needle assembly into the end of the seam and seal.
- Pressurize the air channel between the two seams to between 30 and 35 psi. Following pressure stabilization, take the initial pressure reading, hold the pressure a minimum of 3 minutes, and take a second reading.
- The allowable leak down for the seam is 3 psi.
- If the pressure does not drop below the maximum allowable 3 psi, open the air channel at the end away from the pressure gauge. Air should rush out and the pressure gauge should register an immediate drop in pressure, indicating that the entire length of seam has been tested. If this does not happen, either the air channel is blocked or the equipment is faulty, and the test is not valid.
- Enter the results of the leak test on the appropriate document, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

- Repair the area where the pressure gauge/needle assembly was installed and where the air was released.

Vacuum-Box Testing: The proposed test procedures are as follows:

- Mix a solution of liquid detergent and water and apply an ample amount to the area to be tested. If a seam contains excess overlap or loose edges, it must be trimmed before testing.

- Place a translucent vacuum box over the area and apply a slight amount of downward pressure to the box to seat the seal strip to the liner.

- Apply a vacuum of 3 to 5 psi for a minimum of 15 seconds to the area. Any leaks will become visible by large bubbles.

- Enter the results of the leak test on the appropriate document, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

Spark Testing: Extrusion welded patches, cap, etc., in lieu of being vacuum-box tested, may be "spark" tested. The basic procedures for spark testing are as follows:

- The seam shall be prepared for extrusion welding in accordance with the installer's procedures.

- Just prior to applying the extrusion bead, a small-gauge copper wire is placed into the seam. An 18-gauge bare copper wire usually works well. The wire should be grounded at one end and placed at the edge of the top sheet of the overlap seam. Tucking the wire under the edge of the top sheet will help hold the wire in place during welding, but this should be done prior to grinding to avoid the risk of contamination of the weld area.

- Apply the extrudate bead as normal, and allow the weld to cool.

- Energize the spark tester, and move the electrode wand near a grounding source to determine the maximum length of spark that can be generated. Adjust the output voltage setting until the spark length exceeds the greatest potential leak path distance. This is typically the diagonal distance from the embedded wire to the edge of the weld bead at a "T" joint.

- Once the output voltage has been set, testing may be started. Testing is performed by passing the electrode over the seams with the electrode in contact with the membrane and/or the extruded weld bead. The audible and visual indication of a spark provides the determination of a potential leak path.

- If a potential leak is detected, the area can be repaired by grinding and re-welding. Applying additional weld beads adjacent to the leaking weld is not an acceptable repair technique. This will only lengthen the leak path to the extent that the spark

tester may not be capable of generating a spark of sufficient length to breach the lengthened gap.

- After grinding and re-welding, the seam must be retested. If there is still an indication of a potential leak (spark), it may be required to apply a patch over the entire area.

3.3.2.5 Destructive Testing

Peel and shear seam strength testing shall be carried out on samples of seams removed from the installed panels. For these tests, the following procedures shall be followed:

- Coupon sampling of all field seams, including patches and repair areas, shall be taken by cutting perpendicular to the seams a sample approximately 36 by 12 inches. This sample shall be cut into three 12-by-12-inch samples and labeled with the date and location, and individually marked “Owner Sample,” “QA/QC Sample,” and “Lab QA/QC Sample.” The frequency and location shall be determined by the Engineer but shall not be less than one sample per 500 feet of field seams. These coupons shall be tested on site for peel and shear seam strength and thickness in accordance with D6392.

- Heat-welded seams shall be allowed to cool or warm to about 70°F prior to testing. Solvent seams, when used, shall be allowed to cure according to the manufacturer’s recommendations. Additionally, at the Engineer’s option, approximately 10 percent of the coupons (size 1 by 6 inches) shall be sent to an independent laboratory for confirmation testing. Should the lab and field tests conflict, installation shall halt until the conflict is resolved to the satisfaction of the Engineer.

The Engineer will continuously inspect the installation of the HDPE liner to ensure that the procedures specified in this section are adhered to fully.

Weld specimens shall pass when the results shown in Table 4 are achieved in both peel and shear tests and as follows:

- The break, when peel testing, occurs by Separation In the Plane of the sheet (SIP) not through adhesion failure separation (AD).

- The break is ductile.

- In the event of a failing test result, the following procedures shall be used:

- The Installer shall follow one of two options:

- Reconstruct the seam between any two passed test locations, or

- Trace the weld to an intermediate location at least 10 feet or to where the seam ends in both directions from the location of the failed test. Once the failing limits of the seam are isolated, that portion of the seam shall be reconstructed or capped.

Seams welded prior to and after the failed seam using the same welding device and/or operator shall be tested.

3.3.2.6 Repair Procedures

Damaged or defective geomembrane or seam areas failing a destructive or non-destructive test shall be repaired. The Installer shall be responsible for repair of damaged or defective areas. The repair method shall be decided by the Installer but must be agreed upon by the Engineer. Procedures available include the following:

- Replacement: Remove damaged geomembrane or unacceptable seam and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.
- Patching: Used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Abrading and Re-Welding: Used to repair small seam sections.
- Capping: Used to repair large lengths of failed seams.
- Flap Welding: Used to extrusion-weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.
- In addition, the following procedures shall be observed:
- Surfaces of the polyethylene that are to be repaired by extrusion welds shall be lightly abraded to ensure cleanliness.
- All geomembrane shall be clean and dry at the time of repair.
- Extend patches or caps at least 6 inches for extrusion weld and 4 inches for wedge weld beyond the edge of the defect, and round corner of patch material. The edges of all patches are to be beveled.
- Furthermore, repair verification shall be performed as follows:
- Number and log each patch repair.
- Non-destructively test each repair using methods specified in this Specification.

3.3.2.7 Certification

At the completion of the geomembrane installation, the Installer shall provide the Owner with a certification stating that the geomembrane was installed and tested in accordance with the

Specifications together with a report of the test results. The certification shall be provided to the Owner prior to the demobilization of the installation personnel from the site unless agreed otherwise by the Owner. The report of the test results shall be provided in hard copy and digital format to the Owner and the Engineer not later than 30 days after the installation work has been completed.

3.3.2.8 Completion

At the completion of the installation, the Installer shall provide a set of as-built drawings showing the actual geomembrane panel layout, seams, location of destructive test samples, and the location of major repairs including repaired seams and capped areas. The as-built panel layout must be submitted in hard copy and digital format to the Owner and the Engineer not later than 30 days after the installation work has been completed.

Table 1 – HDPE Geomembrane, Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. avg.)	D5199	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Per roll
▪Lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/L (min.)	D1505/D792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [1] (min. avg.)	D6693 Type IV								20,000 lbs
▪Yield strength		63 lbs/in	84 lbs/in	105 lbs/in	126 lbs/in	168 lbs/in	210 lbs/in	252 lbs/in	
▪Break strength		114 lbs/in	152 lbs/in	190 lbs/in	228 lbs/in	304 lbs/in	380 lbs/in	456 lbs/in	
▪Yield elongation		12%	12%	12%	12%	12%	12%	12%	
▪Break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. avg.)	D1004	21 lbs	28 lbs	35 lbs	42 lbs	56 lbs	70 lbs	84 lbs	45,000 lbs
Puncture Resistance (min. avg.)	D4833	54 lbs	72 lbs	90 lbs	108 lbs	144 lbs	180 lbs	216 lbs	45,000 lbs
Stress Crack Resistance [2]	D5397 (Appendix)	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	Per GRI-GM10
Carbon Black Content (range)	D1603 [3]	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	D5596	Note [4]	Note [4]	Note [4]	Note [4]	Note [4]	Note [4]	Note [4]	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [5]									200,000 lbs
a) Standard OIT	D3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
--OR--									
b) High Pressure OIT	D5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C [5, 6]	D5721								Per each formulation
a) Standard OIT (min. avg.) - % retained after 90 days	D3895	55%	55%	55%	55%	55%	55%	55%	
--OR--									
b) High Pressure OIT (min. avg.) - % retained after 90 days	D5885	80%	80%	80%	80%	80%	80%	80%	

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
UV Resistance [7]	GM11								Per each formulation
a) Standard OIT (min. avg.)	D3895	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	
--OR--									
b) High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	D5885	50%	50%	50%	50%	50%	50%	50%	

1. Of 10 readings; 8 out of 10 readings must be ≥ 7 mils, and the lowest individual reading must be ≥ 5 mils
2. Alternate the measurement side for double-sided textured sheet.
3. Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five (5) test specimens each direction.
   - Yield elongation is calculated using a gauge length of 1.3 inches.
   - Break elongation is calculated using a gauge length of 2.0 inches.
4. P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
   - The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
5. Other methods, such as D4218 (muffle furnace) or microwave methods, are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
6. Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (1) in Category 3.
7. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
8. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
9. The condition of the test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.
10. Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV-exposed samples.
11. UV resistance is based on percent-retained value regardless of the original HP-OIT value

Table 2 – HDPE Geomembrane, textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. avg.)	D5994	Nominal (-5%)	Nominal (-5%)	Nominal (-5%)	Nominal (-5%)	Nominal (-5%)	Nominal (-5%)	Nominal (-5%)	Per roll
▪Lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Asperity Height mils (min. avg.) [1]	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	Every 2nd roll [2]
Density mg/L (min.)	D1505/D792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [3] (min. avg.)	D6693 Type IV								20,000 lbs
▪Yield strength		63 lbs/in	84 lbs/in	105 lbs/in	126 lbs/in	168 lbs/in	210 lbs/in	252 lbs/in	
▪Break strength		45 lbs/in	60 lbs/in	75 lbs/in	90 lbs/in	120 lbs/in	150 lbs/in	180 lbs/in	
▪Yield elongation		12%	12%	12%	12%	12%	12%	12%	
▪Break elongation		150%	150%	150%	150%	150%	150%	150%	
Tear Resistance (min. avg.)	D1004	21 lbs	28 lbs	35 lbs	42 lbs	56 lbs	70 lbs	84 lbs	45,000 lbs
Puncture Resistance (min. avg.)	D4833	54 lbs	72 lbs	90 lbs	108 lbs	144 lbs	180 lbs	216 lbs	45,000 lbs
Stress Crack Resistance [4]	D5397 (App.)	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	Per GRI-GM10
Carbon Black Content (range)	D1603 [5]	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	D5596	Note [6]	Note [6]	Note [6]	Note [6]	Note [6]	Note [6]	Note [6]	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [7]									200,000 lbs
c) Standard OIT	D3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
--OR--									
d) High Pressure OIT	D5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C [7, 8]	D5721								Per each formulation
c) Standard OIT (min. avg.) - % retained after 90 days	D3895	55%	55%	55%	55%	55%	55%	55%	
--OR--									

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
d) High Pressure OIT (min. avg.) - % retained after 90 days	D5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance [7]	GM11								Per each formulation
c) Standard OIT (min. avg.)	D3895	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	N.R. [8]	
--OR--									
d) High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	D5885	50%	50%	50%	50%	50%	50%	50%	

1. Of 10 readings; 8 out of 10 readings must be ≥ 7 mils, and the lowest individual reading must be ≥ 5 mils
2. Alternate the measurement side for double-sided textured sheet.
3. Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five (5) test specimens each direction.
   - Yield elongation is calculated using a gauge length of 1.3 inches.
   - Break elongation is calculated using a gauge length of 2.0 inches.
4. P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
   - The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
5. Other methods, such as D4218 (muffle furnace) or microwave methods, are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
6. Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (1) in Category 3.
7. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
8. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
9. The condition of the test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.
10. Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV-exposed samples.
11. UV resistance is based on percent-retained value regardless of the original HP-OIT value.

Table 3 – Seam Strength and Related Properties of Thermally Bonded Smooth and Textured HDPE Geomembranes

Geomembrane Nominal Thickness	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Hot Wedge Seams [1]							
Shear strength [2], lb/in.	57	80	100	120	160	200	240
Shear elongation at break [3], %	50	50	50	50	50	50	50
Peel strength [2], lb/in.	45	64	76	91	121	151	181
Peel separation, %	25	25	25	25	25	25	25
Extrusion Fillet Seams							
Shear strength [2], lb/in.	57	80	100	120	160	200	240
Shear elongation at break [3], %	50	50	50	50	50	50	50
Peel strength [2], lb/in.	39	52	65	78	104	130	156
Peel separation, %	25	25	25	25	25	25	25

1. Also for hot air and ultrasonic seaming methods
2. Value listed for shear and peel strengths are for four out of five test specimens; the fifth specimen can be as low as 80% of the listed values
3. Elongation measurements should be omitted for field testing

SECTION 4 - WETLAND MATRIX MATERIAL AND VEGETATION

4.0 GENERAL

Per the Drawings, the surface flow wetlands (standalone and polishing) shall be filled with topsoil per the Drawings and then planted with sedges relocated from on-site; the subsurface flow wetland shall be filled with a mixed matrix and then planted with cattails relocated from on-site; the aeration channel shall be filled with rounded rock; and, the rock drain shall be filled with washed limestone.

4.1 PRODUCTS

4.1.1 Topsoil

Topsoil shall be supplied per the Materials List. Any substitutions must be approved by the Engineer, in written, prior to purchase.

4.1.2 Sedges

Sedges shall be relocated from on-site. The source site will be determined by the Engineer.

4.1.3 Subsurface Wetland Mixed Matrix

Mixture of materials shall be as presented in the table below:

Material	% by Volume
1.5” Washed, Rounded Rock	60%
1”-2” Wood Chips	35%
Manure	4.6%
Sulfur Prill	0.38%
Liquid Fish Fertilizer	0.02%

The materials listed above shall be supplied per the Materials List. Any substitutions must be approved by the Engineer, in written, prior to purchase.

4.1.4 Cattails

Cattails shall be relocated from on-site. The source site will be determined by the Engineer.

4.1.5 1.5” Rounded Rock

1.5-inch washed, rounded rock supplied per the Materials List. Rock shall pass 100% on a 2-inch screen and be retained 100% on a 1.5-inch screen. Any substitutions must be approved by the Engineer, in written, prior to purchase.

4.1.6 3”-6” Rounded Rock

3-inch to 6-inch washed, rounded rock supplied per the Materials List. Any substitutions must be approved by the Engineer, in written, prior to purchase.

4.1.7 Washed Limestone

1.5-inch crushed and washed limestone supplied per the Materials List. Rock shall pass 100% on a 2-inch screen and be retained 100% on a 1.5-inch screen. Any substitutions must be approved by the Engineer, in written, prior to purchase.

4.1.8 1” to 2” Wood Chips (Added - Addendum 01)

1-inch to 2-inch washed wood chips supplied per the Materials List. Wood chips shall pass 100% on a 2-inch screen and be retained 100% on a 1-inch screen with minimal fines. Any substitutions must be approved by the Engineer, in written, prior to purchase.

4.2 EXECUTION

4.2.1 Topsoil

Topsoil shall be placed in the surface flow wetlands. Placement equipment must not impact the liner. Use of equipment on the liner is permissible only in accordance with the manufacturer’s recommendations. The topsoil shall be spread evenly and graded in accordance with the Drawings. The topsoil shall not be compacted by spreading equipment or machinery.

4.2.2 Sedges

Sedges shall be hand dug from the existing location with care to remove the plant roots and surrounding topsoil. Care should be taken during removal to limit disturbance to the surrounding area and other vegetation. After removal, the plants shall be transported to the surface flow wetlands and replanted, by hand, with approximately 1.5-foot spacing.

4.2.3 Subsurface Wetland Mixed Matrix

The mixed matrix shall be mixed on-site if a mixing site is allowable according to Anderson. Otherwise, the mixed matrix shall be mixed off-site. At the mixing site, the material shall be mixed in maximum volumes of one truckload. The unloading and mixing process must be observed by the Engineer. When the matrix is adequately mixed, it shall be loaded in the transport truck for hauling. From the mix pile, a minimum of 1-ft depth shall be left in place to ensure that no ground materials are scraped into the matrix mix. Loading and unloading shall be performed to minimize gradation of the material.

Placement equipment must not impact the liner. Use of equipment on the liner is permissible only in accordance with the manufacturer's recommendations. The mixed matrix shall be spread evenly and graded in accordance with the Drawings. The mixed matrix shall not be compacted by spreading equipment or machinery.

4.2.4 Cattails

Cattails shall be hand dug from the existing location with care to remove the plant tubers. Care should be taken during removal to limit disturbance to the surrounding area and other vegetation. After removal, the plants shall be transported to the surface flow wetlands and replanted, by hand, with approximately 1.5-foot spacing.

4.2.5 Rounded Rock (Revised - Addendum 01)

Rounded shall be placed in the inlet and outlet of the surface flow wetlands (Standalone and Polishing), subsurface flow wetland, and rock drain, as well as the entire aeration channel. Loading and unloadinged of the rounded rock shall be performed to minimize gradation of the material. Placement equipment must not impact the liner. Use of equipment on the liner is permissible only in accordance with the manufacturer's recommendations. The rounded rock shall be spread evenly and graded in accordance with the Drawings. The rounded rock shall not be compacted by spreading equipment or machinery.

4.2.6 Washed Limestone (Revised - Addendum 01)

Washed limestone shall be placed in the rock drain. ~~surface flow wetlands.~~ Loading and unloadinged of the limestone shall be performed to minimize gradation of the material. Placement equipment must not impact the liner. Use of equipment on the liner is permissible only in accordance with the manufacturer's recommendations. The limestone shall be spread evenly and graded in accordance with the Drawings. The limestone shall not be compacted by spreading equipment or machinery.

4.2.7 Calcine Clean Cover (Added - Addendum 03)

In areas disturbed during the construction of the wetland demonstratration, if calcines are present at the final grade elevation outside of lined areas, the calcines shall be covered to a minimum depth of 6-inches with suitable backfill.

4.3 TESTING

There are no testing requirements for this Section.